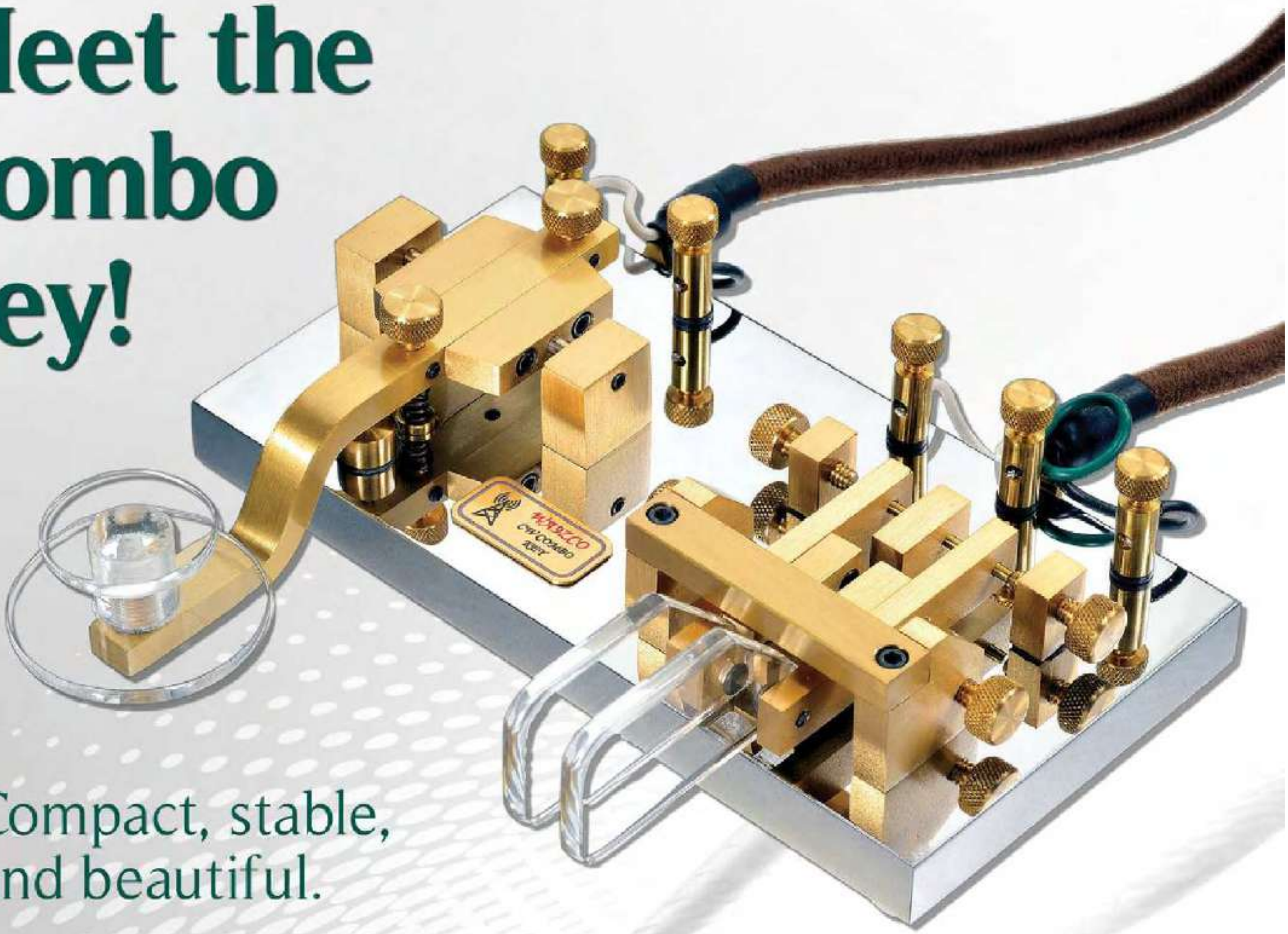
Build Your Own D-STAR Hotspot with a Raspberry Pi Page 30

QST
DIGITAL EDITION

ARRL The national association for AMATEUR RADIO®
February 2020 www.arrl.org
DEVOTED ENTIRELY TO AMATEUR RADIO

Meet the Combo Key!



Compact, stable, and beautiful.

QST Reviews

FlexRadio Systems
FLEX-6600M HF and 6-Meter SDR Transceiver

DX Engineering
RX Share Audio Switch

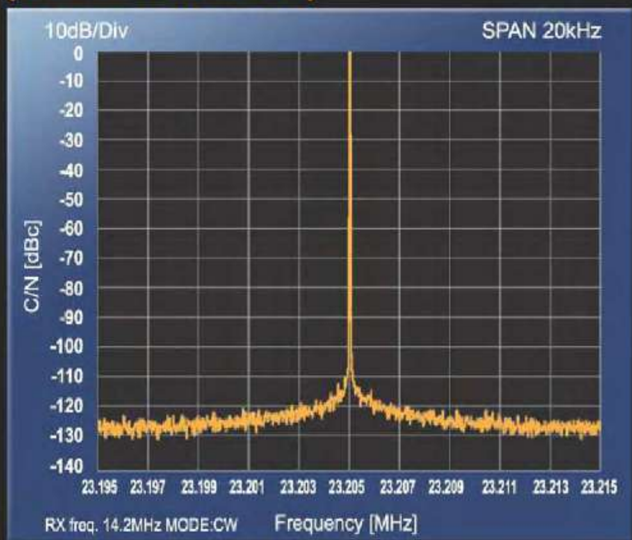
Workbench "Third Hand" Circuit Board Holders

FTDX101 TECHNICAL HIGHLIGHT - #3

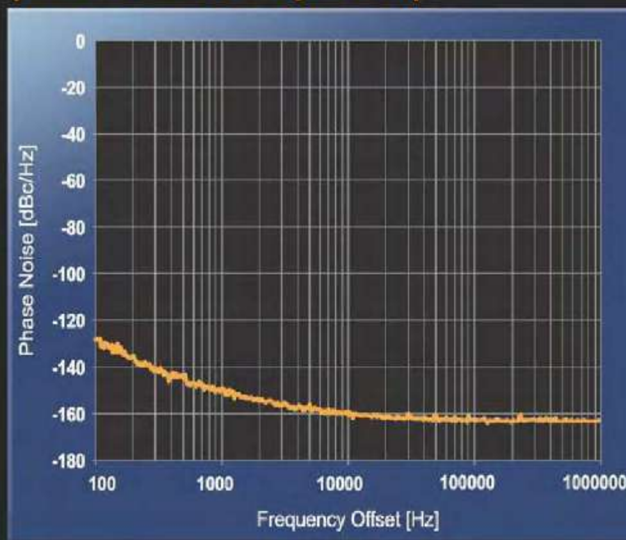
The 400 MHz HRDDS (High Resolution Direct Digital Synthesizer)
Ultra Low-Noise Local Oscillator System

Provides an outstanding Low-noise, High quality Local oscillator signal that greatly contributes to the excellent multi-signal and the close signal proximity characteristics of the receiver

1st Local OSC Carrier to Noise Ratio (14.2 MHz / Mode CW)



1st Local OSC Phase Noise: -150dBc/Hz (14.2 MHz / 2 kHz separation)



±0.1ppm High Precision TCXO

400 MHz HRDDS Unit

HF/50MHz TRANSCEIVER
FTDX101MP 200W

HF/50MHz TRANSCEIVER
FTDX101D 100W

* Microphone M-1: Optional

C4FM/FM 144/430 MHz
Dual Band 5W
Digital Transceiver
FT-70DR
《 700 mW Loud and Clear audio, Commercial Grade Specifications 》
WIRES-X
Portable Digital Node
Available
C4FM/FM 144/430 MHz
Dual Band 5 W
Digital Transceiver
FT3DR
《 Improved 66 ch GPS receiver included 》
WIRES-X
Portable Digital Node
Available
C4FM/FM 144/430 MHz
Dual Band 5 W
Digital Transceiver
FT2DR
《 Improved 66 ch GPS receiver included 》
System Fusion II
C4FM Digital
Pursuing Advanced Communications
WIRES-X
Portable Digital Node
Available
C4FM/FM
144/430 MHz Dual Band 50 W
Digital Transceiver
FTM-100DR
《 Improved 66 ch GPS receiver included 》
C4FM/FM 144/430 MHz
Dual Band Dual Receive Digital Repeater
DR-2X
WIRES-X
Portable Digital Node
Available
C4FM/FM
144/430 MHz Dual Band 50 W
Digital Transceiver
FTM-400XDR
《 Improved 66 ch GPS receiver included 》
C4FM/FM 144/430 MHz Dual Band 50 W
Digital Transceiver
FTM-7250DR
《 Heavy Duty 50 Watts High Power 》
C4FM/FM 144 MHz 65 W
Digital Transceiver
FTM-3200DR
《 Genuine 65 Watts High Power 》
C4FM/FM 430 MHz 55 W
Digital Transceiver
FTM-3207DR
《 Heavy Duty 55 Watts High Power 》
CW/SSB/AM/FM/C4FM
HF/50/144/430 MHz Wide-Coverage
100 W All Mode Transceiver (144/430 MHz: 50 W)
FT-991A
《 Real-Time Spectrum Scope included 》
System Fusion II Supports All C4FM Portables and Mobiles
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Specifications subject to change without notice. Some accessories and/or options may be standard in certain areas. Frequency coverage may differ in some countries. Check with your local Yaesu Dealer for specific details.

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Columns

Digital and Mobile Editions

ARRL members can access the digital edition via a link at **www.arrl.org/qst**, download our iOS app from the iTunes Store, and download our Android app from the Google Play Store.

Departments

Write for *QST*

www.arrl.org/qst-author-guide
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Our Cover

The combo key by Marc Alan Winzenried, WA9ZCO, was one of the entries in *QST*'s recent Key Competition. Though it was not one of the winners, we felt its design and construction warranted a closer look. For an overview of how this beautiful piece of gear is made, see "CW Combo Key" on page 33.

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For all your base station and repeater needs, DIAMOND has an antenna that will work for you.

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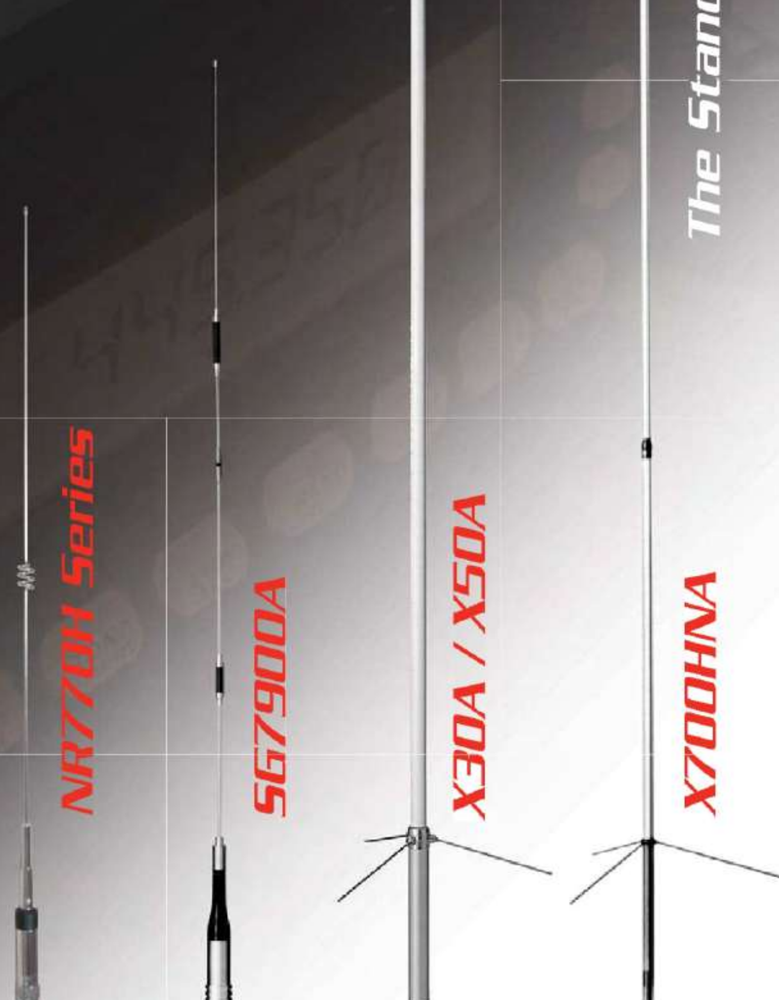
X700HNA Special Features:

- Heavy duty fiberglass radomes
- Four section assembly
- Overlapping outer shells for added strength
- Stainless steel mounting hardware & radials
- Strong waterproof joint couplings
- Type-N cable connection
- Wideband performance
- Highest gain Dual-band Base Antenna!

The Standard By Which All Others Are Judged

Here is a small sample of our wide variety of antennas

Model	Bands	Length Ft.	Max Pwr. Rating	Conn.
Dualband Base Station/Repeater Antennas				
X700HNA (4 section)	2m/70cm	24	200	N
X510HD (3 Section)	2m/70cm	17.2	330/250	UHF or N
X300A (2 Section)	2m/70cm	10	200	UHF or N
X200A (2 Section)	2m/70cm	8.3	200	UHF
X50A (1 Section)	2m/70cm	5.6	200	UHF or N
X30A (1 Section)	2m/70cm	4.5	150	UHF
Monoband Base Station/Repeater Antennas				
F23H (3 Section)	144-174 MHz (W/ Cut Chart)	15	350	UHF
F22A (2 Section)	2m	10.5	200	UHF
CP22E (Aluminum)	2m	8.9	200	UHF
F718A (Coax Element)	70cm	15	250	N
Dualband Mobile Antennas				
SG7900A	2m/70cm	62.2 in.	150	UHF or NMO
SG7500A	2m/70cm	40.6 in.	150	UHF or NMO
NR770H Series	2m/70cm	38.2 in.	200	UHF or NMO
MR77 Series	2m/70cm	20 in.	70	Mag Combo
AZ504FXH	2m/70cm	15.5 in.	50	UHF
AZ504SP	2m/70cm	15.5 in.	50	UHF
NR7900A	2m/70cm	57 in.	300/250	UHF
Monoband Mobile Antennas				
NR22L	2m	96.8 in.	100	UHF
M285	2m	52.4 in.	200	UHF or NMO



RF PARTS COMPANY

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Howard E. Michel, WB2ITX, ARRL Chief Executive Officer, hmichel@arrl.org

Second Century

Open Technology for Opening Minds

When I first walked around a ham flea market as a teenager, the vintage equipment was generally military surplus, or older first-generation SSB rigs. Now, the vintage gear at hamfest flea markets is Collins and Drake equipment that was state-of-the-art in my youth.

This gear required technical know-how to operate. One needed to retune the rig — dip the plate — when changing frequency any significant amount. Back then, the technology was "open." By that, I mean equipment was built with vacuum tubes, discrete semiconductors, and discrete resistors, capacitors, and inductors. You could use a VOM, O-scope, simple hand tools, a soldering iron, and a schematic diagram to understand what was working and what was not. You could "look under the hood" and repair or modify the rig.

In 1971, Intel produced the 4004 microprocessor and everything changed. Today's top rigs are computing marvels, built using surface-mount components and with major functionality defined in a silicon wafer and software. The average ham can't repair or modify such a rig, even with an engineering degree. Today's state-of-the-art equipment inches closer to plug and play.

With that in mind, imagine that you've just left a hamfest. Returning to your hotel, you get on an elevator, and a young woman notices your call sign badge. She asks, "What do those letters and number mean?" You have the time it takes for the elevator to go up five floors to communicate your passion for amateur radio to that young person. What do you say?

You can't say it's to talk around the world; she can do that now from her cell phone or using the internet. You can't say it's to get under the hood of a modern radio; it's all software and silicon. Or is it?

Consider the banner ARRL rolled out last summer, which said, "Radio communications: skill, service, and discovery." Build your elevator speech around that concept. And ARRL can do more to help you.

ARRL is developing low-cost (target $5.00), build-it-in-an-hour receiver and transmitter kits. We intend to make these available at nominal cost to members and radio clubs who want to have a different "soldering experience" at their next hamfest. We've even received a donation (and would like to receive more) to make some available for free. We will have, as part of ARRL's booth at Orlando HamCation in February, a build-a-radio experience using a kit designed by member Levi Zima, KN4YHS, a 21-year-old RF designer. Imagine the excitement that a pair of new hams might have, one building a receiver and one building a transmitter, going outside and communicating using a radio they built.

Let's try to recapture some of the excitement — the skills and discovery — of exploring how radio works.

If you have ideas or experiences that might help us with our build-a-radio kit, please contact Product Development Manager Bob Inderbitzen, NQ1R, at **nq1r@arrl.org**.

I encourage your comments to me at **ceo@arrl.org**.

Where to Meet WB2ITX

January 24 — Winterfest & ARRL Midwest Division Convention, Collinsville, Illinois **https://winterfest.slsrc.org**

February 7 – February 9 — Orlando HamCation, Orlando, Florida **www.hamcation.com**

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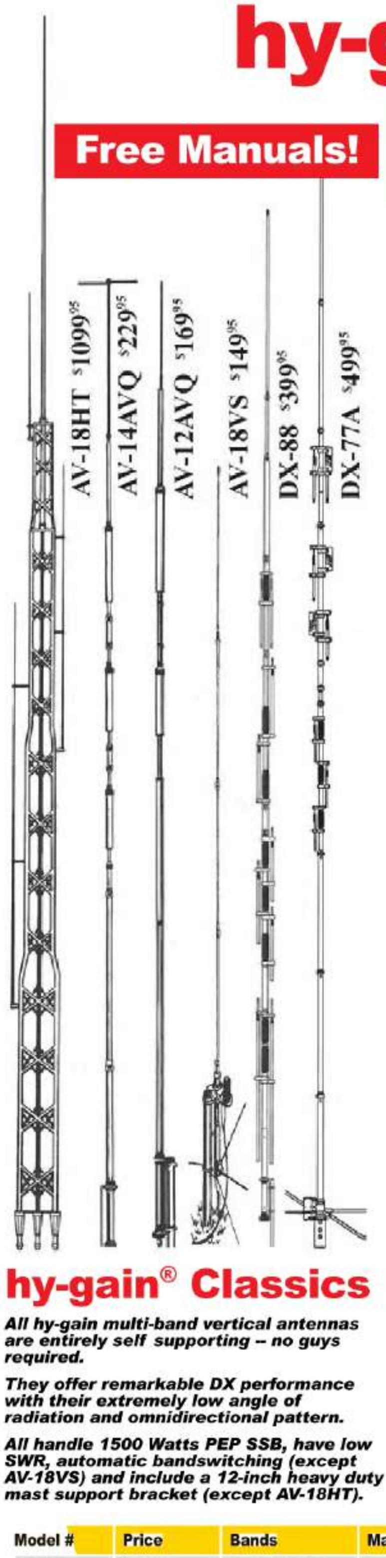

hy-gain® Classics

All hy-gain multi-band vertical antennas are entirely self supporting – no guys required.

They offer remarkable DX performance with their extremely low angle of radiation and omnidirectional pattern.

All handle 1500 Watts PEP SSB, have low SWR, automatic bandswitching (except AV-18VS) and include a 12-inch heavy duty mast support bracket (except AV-18HT).

Compression clamps are used for radiators. Includes all stainless steel hardware. Recessed SO-239 prevents moisture damage. Hy-gain verticals go up easily with just hand tools and their cost is surprisingly low. Two year limited warranty.

AV-18HT, $1099.95. (10, 12, 15, 20, 40, 80 M, 160, 17 Meters optional) 53 ft., 114 lbs.

Standing 53 feet tall, the famous *Hy-Gain HyTower* is the world's best performing vertical! The AV-18HT features automatic band selection achieved through a unique stub-decoupling system which effectively isolates various sections of the antenna so that an electrical 1/4 wavelength (or odd multiple of a 1/4 wavelength) exists on all bands. Approximately 250 kHz bandwidth at 2:1 VSWR on 80 Meters. The addition of a base loading coil (**LC-160Q, $149.95**), provides exceptional 160 Meter performance. **MK-17, $119.95**. Add-on 17 Meter kit. 24 foot tower is all rugged, hot-dip galvanized steel and all hardware is iridited for corrosion resistance. Special tilt-over hinged base for easy raising & lowering.

AV-14AVQ, $229.95. (10, 15, 20 ,40 Meters) 18 ft., 9 lbs.

The Hy-Gain AV-14AVQ uses the same trap design as the famous Hy-Gain Thunderbird beams. Three separate air dielectric Hy-Q traps with oversize coils give superb stability and 1/4 wave resonance on all bands. Roof mount with Hy-Gain **AV-14RMQ kit, $119.95**.

AV-12AVQ, $169.95. (10, 15, 20 Meters) 13 ft., 9 lbs.

AV-12AVQ also uses Thunderbird beam design air dielectric traps for extremely Hy-Q performance. This is the way to go for inexpensive tri-band performance in limited space. Roof mount with **AV-14RMQ kit, $119.95**.

AV-18VS, $149.95. (10, 12, 15, 17, 20, 30, 40, 80 Meters) 18 ft., 4 lbs.

High quality construction and low cost make the AV-18VS an exceptional value. Easily tuned to any band by adjusting feed point at the base loading coil. Roof mount with Hy-Gain **AV-14RMQ kit, $119.95**.

DX-88, $399.95. (10, 12, 15,17, 20, 30, 40, 80 Meters) 160 Meters optional) 25 ft., 18 lbs.

All bands are *easily* tuned with the DX-88's *exclusive* adjustable capacitors. 80 and 40 Meters can even be tuned from the ground without having to lower the antenna. Super heavy-duty construction. DX-88 OPTIONS: 160 Meter add-on kit, **KIT-160-88, $249.95. Ground Radial System, GRK-88, $129.95. Roof Radial System, RRK-88, $119.95**.

DX-77A, $499.95. (10, 12, 15, 17, 20, 30, 40 Meters) 29 ft., 25 lbs.

***No** ground radials required!* Off-center-fed Windom has 55% greater bandwidth than competitive verticals. Heavy-duty tiltable base. Each band independently tunable.

Model #	Price	Bands	Max Power	Height	Weight	Wind Surv.	Rec. Mast
AV-18HT	$1099.95	10, 15, 20, 40, 80	1500 W PEP	53 feet	114 pounds	75 MPH	————
AV-14AVQ	$229.95	10, 15, 20, 40	1500 W PEP	18 feet	9 pounds	80 MPH	1.5-1.625"
AV-12AVQ	$169.95	10, 15, 20 M	1500 W PEP	13 feet	9 pounds	80 MPH	1.5-1.625"
AV-18VS	$149.95	10 - 80 M	1500 W PEP	18 feet	4 pounds	80 MPH	1.5-1.625"
DX-88	$399.95	10 - 40 M	1500 W PEP	25 feet	18 pounds	75 MPH no guy	1.5-1.625"
DX-77A	$499.95	10 - 80 M	1500 W PEP	29 feet	25 pounds	60 MPH no guy	1.5-1.625"

80-6 Meters

Hy-Gain's new AV-680 adds 75/80 Meters with no radials!

Includes 40, 30, 20, 17, 15, 12, 10 and 6 Meters operation with low 17 degree radiation angle and omni-directional world-wide coverage. No ground or radials needed. Handles full 1500 Watts key down continuous for two minutes.

AV-680
$599.95

Highly Efficient

The AV-680 uses quarter wave stubs on 6, 10, 12 and 17 meters and very efficient end loading coil and capacity hats on 15, 20, 30, 40 and 80 Meters – no traps. End loading allows efficient operation with a low profile. Resonators are placed in parallel not in series.

Each band individually tunable

Extra wide low VSWR bandwidth. End fed with broadband matching unit. Single coax cable feed. Automatic bandswitching.

Sleek and low-profile

Low 2.9 sq. ft. wind surface area. Small footprint for mounting easily on decks, roofs and patios. 26 feet, 18.5 lbs.

Built-to-last

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Hy-Gain verticals are the best built, best performing and best priced multiband verticals available today.

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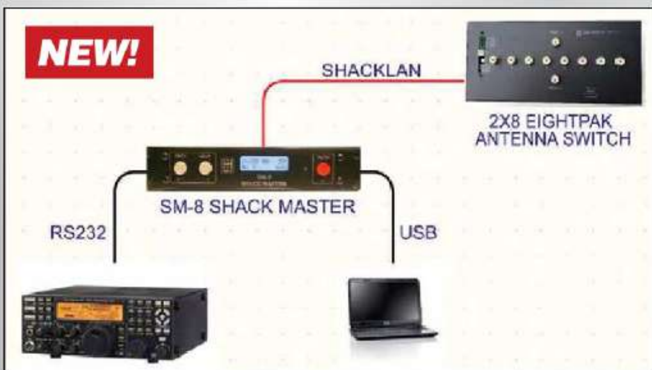
Wiring are simple phone cables that daisy chain to all the devices. Wireless control is also available to your tower-located switches. Call us to learn how to set up simple or complex systems. Below is a simple basic system that can switch antennas as you change bands. We can interface to any radio CAT port, not just RS232.



A more complex system could be a SO2R contest station as shone.

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Capture the whole band or the whole HF spectrum at once with the Shared Apex Loop Array 2nd Generation. Can be remote controlled over the internet or in your station. 8 directions of directivity.

The Shared Apex Loop Array™ is a revolutionary receiving antenna that will change the way that you listen to the radio! The patented design provides performance in a size and over a wide range of frequencies that will please both the rag-chewer and DXer alike.

Three models to choose from:

- AS-SAL-30 - optimized for VLF, BCB, 1.8-10 MHz
- AS-SAL-20 - optimized for BCB, and 1.8-30 MHz
- AS-SAL-12 - optimized for 3-30 MHz

StackMatch

The original, not the imitations. For phasing 2, 3, 4 and even 6 antennas. Also it can be used to combine vertical and horizontal polarized antennas to diminish fading.

PowerMaster II

RF Power and SWR meter. Couplers for 3 kW, 10 kW or higher available for HF/6 m. VHF and UHF couplers for 1.5 kW. You can connect up to 5 couplers to the display to monitor RF power on different TX lines.

OM2000A+ – OM2000+

The **OM2000A+** is the lightest and smallest 2000 W fully automatic HF/6 m power amplifier in the market. Its manual tuning version, the **OM2000+**, is our affordable unmatched best-seller.

Frequency coverage:
Amateur bands 1.8 – 29.7 MHz including WARC + 50 MHz

Power output: 2000+ W in SSB/CW on HF bands, 1500 W in RTTY
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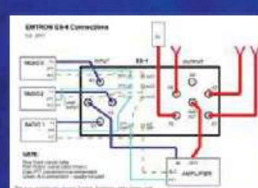

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Becky R. Schoenfeld, W1BXY, bschoenfeld@arrl.org

Member Spotlight

Skip Paulsen, W1PV

ARRL Life Member Charles "Skip" Paulsen, W1PV, has been enjoying the changes in ham radio for 60 years. His father was a radio operator in World War II, and taught Skip Morse code when he was about 10. Ham radio came a few years later, in high school, when Skip joined the school radio club. His first license, in November 1960, was WVP2UM, and he upgraded to General, WA2PUM, a few months later. Skip tested for his Amateur Extra-class license during his senior year, but didn't pass. "It was a rude awakening," he said.

Skip Paulsen, W1PV, with some of his antennas.

He went into the military where he served in the Army Signal Corps, stationed in Thailand during the Vietnam War. There, Skip had access to a first-class Collins S-Line station, and it interested him in getting back into ham radio. His license had expired, so MARS operator Bud Johnson, AB9AD, gave Skip the Conditional exam, which he passed.

An "Extra" Long Day

After 2 years in the Army, Skip got back home and he and his wife, Donna, settled in Danbury, Connecticut. Incentive licensing had kicked in by then, and you needed an Amateur Extra-class license if you wanted to get to the best DX. At the FCC office on Christopher Street in New York City, Skip was told that his Conditional license meant he had to start from scratch. In one day, Skip passed the General code test (13 WPM), General theory, Advanced theory, the Amateur Extra code test (20 WPM), and the Amateur Extra theory test. "It had to be 6 to 8 hours of testing," Skip said. "I was toast, but I was happy." Skip was given WA1SCV, which he changed to W1PV, for its ease in CW and phonetics.

Peaks and Valleys

During his 14 years in Connecticut, Skip chased DX and got into VHF from 6 meters to 10 GHz. He had always been interested in the OSCAR satellites, and made contacts through OSCAR 6, 7, and 8.

In 1986, Skip's employer at the time, AT&T, transferred him to the company headquarters in New Jersey. He and his wife, Donna, moved to Pennsylvania, just over the New Jersey line, and have been there ever since. His Pennsylvania home is in a valley — not ideal for a ham who loves VHF — so Skip started over with a ground plane antenna and "moved from one thing to another" in the wide world of everything ham radio has to offer.

Hooked on Bounce

By the time Skip retired 6 years ago, his big hobby was bicycling. He enjoyed weekly rides with his local cycling club and, by his own admission, "radio was minimal." However, 3 years ago, while putting up antennas at his son's house for a VHF contest, Skip had a heart attack. "I got first-class medical care, but the damage was done," he said. No longer able to bicycle, he returned to ham radio, buying new equipment in the hope of giving EME a try. "Sure enough, the first time I tried it, I worked about a dozen stations, and I got hooked. It's just a fantastic aspect of radio," he said.

These days, Skip does EME on 2 meters, 432 MHz, and 1296 MHz, and he has "a yard full of aluminum, and plans to expand." Worked All States is a favorite award — Skip holds the basic award as well as Bicentennial, satellite (prior to OSCAR 10), 160 meters, and 2 meters (49 of his 2-meter contacts were on EME — Illinois was the holdout, and he got that one on meteor scatter). He's currently chasing WAS on 432 and 1296. Skip is still DXing and has 330 entities confirmed. He hopes to achieve DXCC Honor Roll this winter.

"Ham radio is a big house. There's lots of room in here for everybody," Skip said. "I'm sitting here trying to figure out what's next and what's fun."

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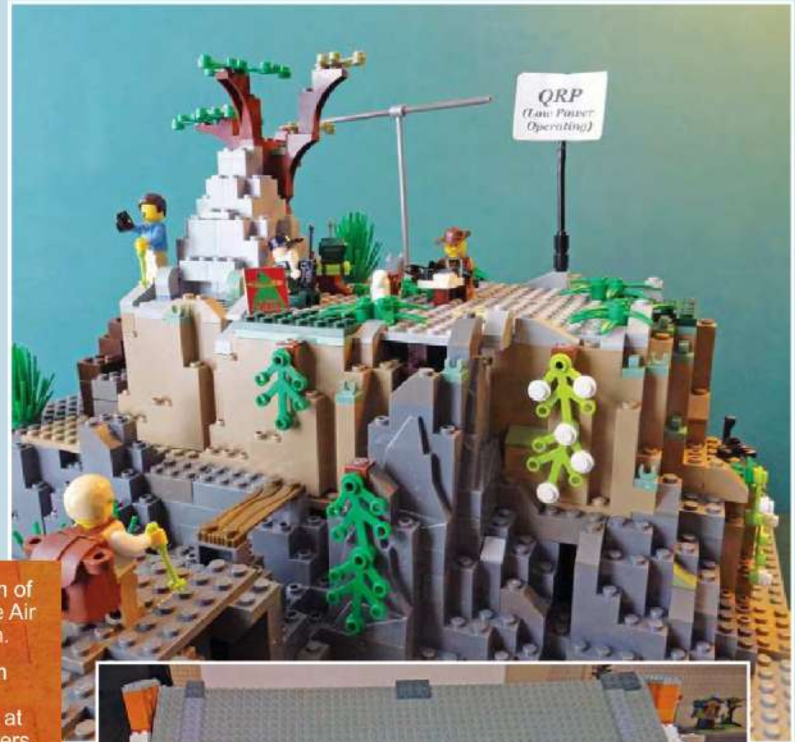
Up Front

LEG-O-HAM

At last year's Western Carolina Amateur Radio Society (WCARS) Hamfest in Waynesville, North Carolina, the chairperson, Ruth Berner, WA4VT, decided to try something different.

Ruth and her husband, Doug, KN4AYW, are both "AFOLs" — Adult Fans of LEGO. It is an artistic activity with adult participants throughout the world. Ruth combined amateur radio and LEGO art at the event, calling it LEG-O-HAM 1.0. The exhibition was a hit and attracted a great deal of interest.

Rumor has it LEG-O-HAM 2.0 will appear at the 2020 WCARS Hamfest on July 25 at the Haywood County North Carolina Fairgrounds.



A LEGO depiction of a Summits on the Air (SOTA) operation.

W1AW, the Hiram Percy Maxim Memorial Station at ARRL Headquarters.

Ruth Berner, WA4VT, at the LEG-O-HAM 1.0 display.

Lou Laderman, WØFK, notes that one of the fringe benefits of living in St. Louis, Missouri is that Heil Sound is just across the Mississippi River in Fairview Heights, Illinois. When Lou visited the company, he was able to park in one of two specially reserved spaces.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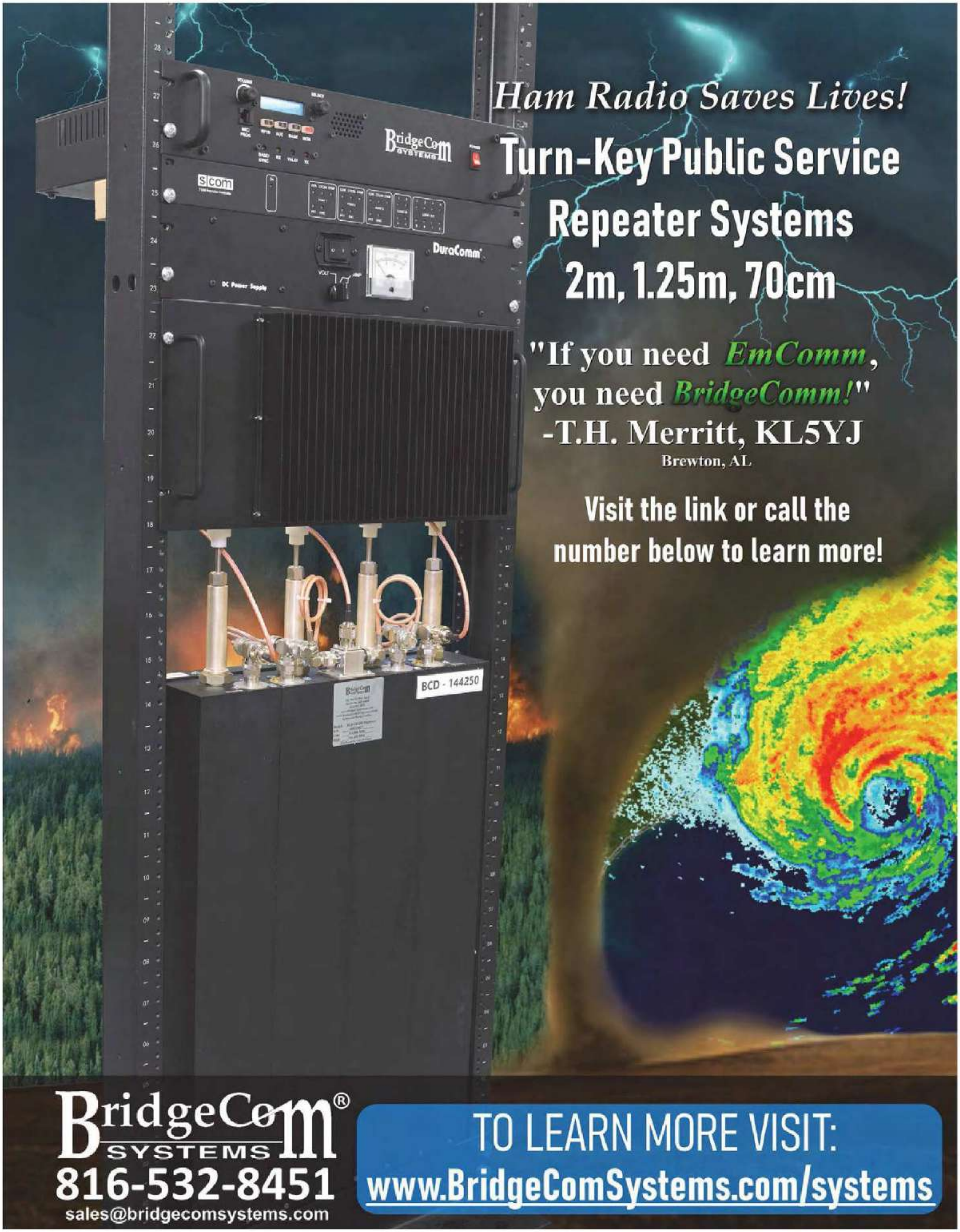

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Correspondence

Letters from Our Members

Gil Gildersleeve

I have been rereading some of my *QST* magazines from the 1950s and '60s. One of the things I enjoy in these magazines is the cartoons in each edition. Each cartoon has its own appropriate story to tell and is signed "W1CJD," better known as Phil "Gil" Gildersleeve, W1CJD (SK). It would have been a pleasure to have met Gil, but I'm happy to enjoy his work all these years later.

George Dominick, W4UW
Knoxville, Tennessee
Life Member

Hams on *Hazel*

I was watching an old episode of *Hazel* with my wife on one of the nostalgia channels, and to my delight the episode was all about ham radio. The episode highlighted a problem with the Baxter's television that they thought was caused by an amateur radio operator who was a friend of their son. The ham asked the power company to visit, and the technician found that the problem was actually a heating pad!

It brings to mind all the interference we deal with today, and how hams are occasionally blamed for problems that are not our fault. Looks like little has changed.

George P. Orphan, KG4DXJ
Jacksonville, Florida

Remembering the Milestones

With the solar flux hovering around 70 and diminished prospects for working new DXCC entities with my 5 W and simple wire antennas, I have been spending more time indulging my interest in the historical milestones of radio theory, experimentation, and invention. Of course, as a ham I am especially interested in amateurs' early contributions to the science and art of radio.

My interest in these areas has been heightened by the upcoming centennial anniversaries of the major milestones in the exploration of the shortwave spectrum by our predecessors at ARRL during the 1920s. I encourage my fellow ARRL members with similar interests to relive the thrilling excitement of those years by reading the relevant articles in issues of *QST* published between 1921 and 1924. You might begin with Paul F. Godley's, "Official Report on the Second Transatlantic Tests," from the February 1922 issue of *QST*. He reports on his experiences in a tent in the December wind, rain, and cold of Ardrossan, Scotland, where, sponsored by ARRL, he went to see if US amateurs could actually reach Europe.

I look forward with great anticipation to whatever ARRL plans for our celebration of the truly significant explorations by its members, here and abroad, of the shortwave spectrum using new circuits and new antenna concepts during the early 1920s.

Gene Pearson, AA8MI
Perrysburg, Ohio
Life Member

Insurance When You *Really* Need It

After 45 years in amateur radio, I suffered my first lightning incident in August 2019, when lightning struck a fence post in my back yard, about 20 feet from my station. My wife and I were in our living room at the time.

We rushed into the station and discovered that we had neglected to disconnect the station power and feed lines. I always do this during "lightning season" here in Florida, but this one time I had forgotten. It cost me dearly.

The strike took out our Wi-Fi router, two computers, a monitor, and our entire station. The Icom IC-7300 was dead as a rock, the Ameritron ALS-600 was equally unresponsive, and my SteppIR vertical antenna was broken. The strike got my NVIS dipole on 75 meters as well, blowing an insulator off the fence and breaking the wire, in addition to burning out the center conductor on the feed line.

We immediately emailed the ARRL equipment insurance provider that Sunday afternoon. On Monday, we received a response from their agent in Chicago. By Wednesday we were contacted by an adjuster in Boston, and on Friday they cut us a check, which arrived 5 days later.

The service from the insurance company was superb — quick, painless, and much appreciated! We would urge everyone to take advantage of this low-cost equipment insurance as an alternative to funding an entire station replacement, should a disaster strike. It is a terrific ARRL member benefit.

John, KE4D, and Libby, KB4FFO, Veach
Leesburg, Florida

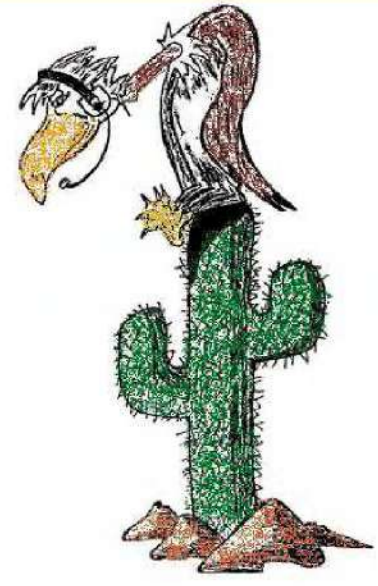
Send your letters to "Correspondence," ARRL, 225 Main St., Newington, CT 06111. You can also submit letters by fax at 860-594-0259, or via email to **letters@arrl.org**. We read every letter received, but we can only publish a few each month. We reserve the right to edit your letter for clarity, and to fit the available page space. Letters published in "Correspondence" may also appear in other ARRL media. The publishers of *QST* assume no responsibility for statements made by correspondents.

Yuma Hamfest

& Southwestern Division Convention

Yuma, Arizona

Feb. 14 & 15, 2020



Yuma County Fairgrounds
2520 East 32nd Street, Yuma, Arizona

www.yumahamfest.org

Check the Website for Additional Information

Gates Open for Camping Thursday, 2 pm Vendor Setup Friday, 7 am - Noon	Event Hours Friday, Noon - 5 pm Saturday, 8 am - 5 pm	Hamfest Dinner & Grand Prize Drawing Saturday Night 6:00 - 8:00 pm

Vendors and Exhibitors

Hourly Door Prizes

Consignment Sales

License Testing

On-site RV Camping

Buzzard BBQ

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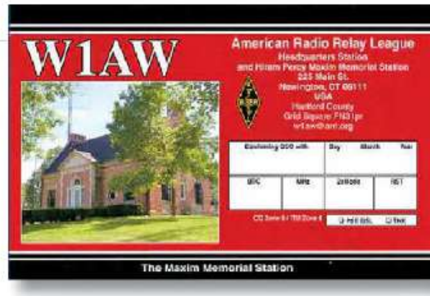
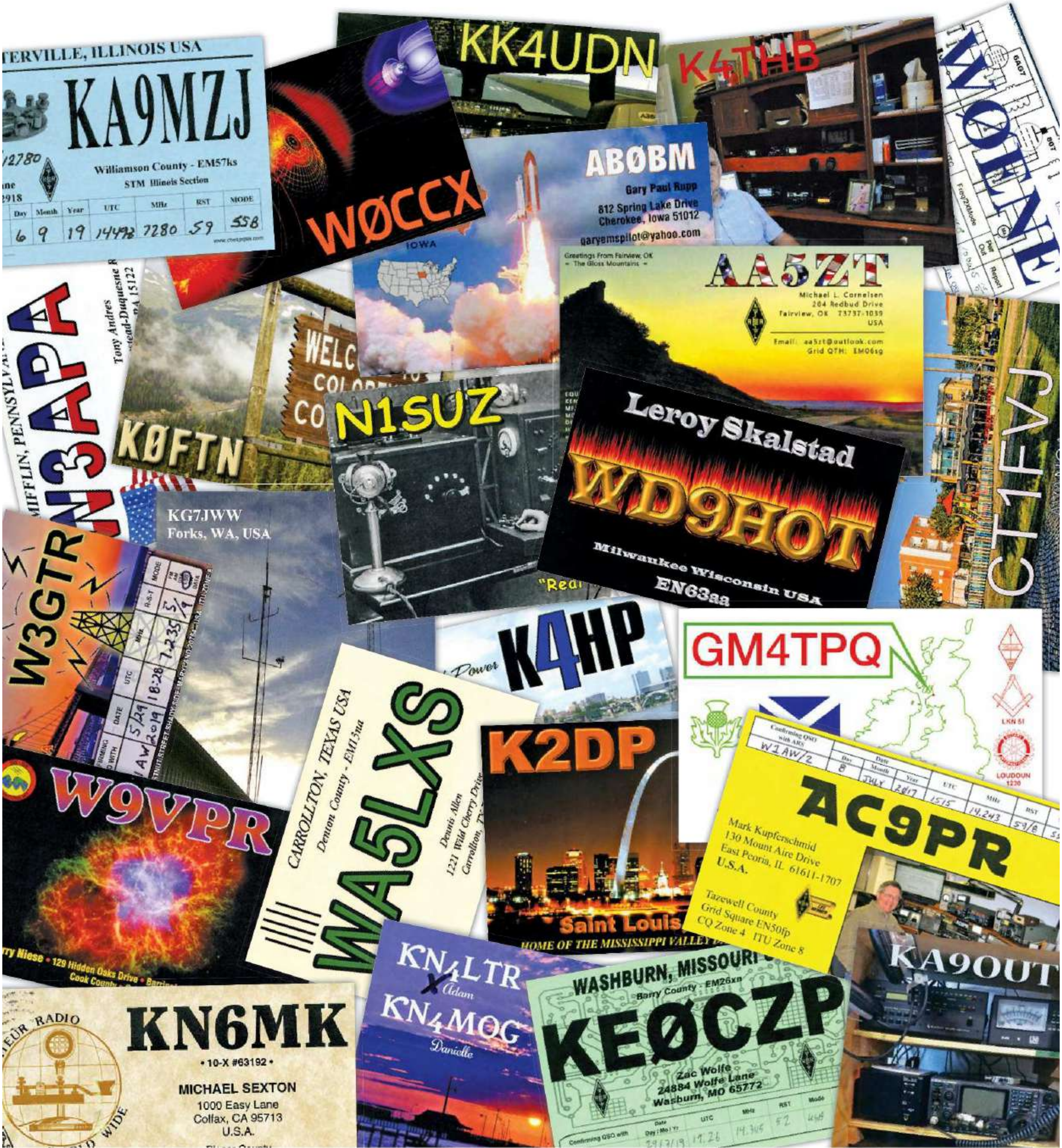
W1AW/7 Special Event Station
Email: info@yumahamfest.org

W1AW's QSL File

Every month, W1AW receives hundreds of QSL cards from hams all over the world, confirming contact with the Hiram Percy Maxim Memorial Station at ARRL Headquarters. Maybe you'll recognize an on-air friend — or even yourself — among these recent cards.



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Build Your Own D-STAR Hotspot

Figure 1 — The PiHat mounted on a Raspberry Pi3 microcomputer.

No D-STAR repeaters nearby? Assemble this inexpensive hotspot and join the D-STAR universe!

Bob Wilton, KF5TPQ

A D-STAR hotspot is a miniature repeater located inside your home. Using your D-STAR transceiver, you connect to the hotspot, and it uses your internet connection to link you to the global D-STAR network — just like a full-fledged D-STAR repeater.

There are commercially available hotspots, but you can create your own inexpensive version with a prebuilt *PiHat* module that plugs directly onto the top of a Raspberry Pi microcomputer. This will effectively turn the microcomputer into a hotspot known as a *Pi-Star*.

Our PiHat is a multimode digital voice modem (MMDVM) hotspot that costs less than $90, including the cost of the Raspberry Pi. I'll address the PiHat installation process that includes downloading the Pi-Star image and transferring it to an SD card, booting up Pi-Star for the first time, interfacing it to your Wi-Fi, and then configuring the resulting Pi-Star by using your radio. I will present a step-by-step process in order to make this easy, even for those with little D-STAR and Pi-Star knowledge.

Before beginning, you may want to review online resources on PiHat, Pi-Star, and Raspberry Pi computers. Helpful sources include the Pi-Star homepage at **www.pistar.uk**, the Pi-Star manual at **https://amateurradionotes.com/images/1-Playing_with_Pi-Star.pdf**, and a guide for D-STAR at **www.roblocher.com/whitepapers/dstar.html**. There are also YouTube videos to help you understand D-STAR configurations.

Step 1

Once you've acquired an MMDVM hotspot board (search on Amazon) and a Raspberry Pi microcomputer, begin by plugging the PiHat onto the top of the Raspberry Pi, as shown in Figure 1 (above).

Next, go to **www.pistar.uk/downloads** and download the Pi-Star image (choose the one based on your Raspberry Pi model) to your PC. Insert an SD card into your PC, possibly using an adapter if needed, and install the image on the card using *Etcher* software (**www.balena.io/etcher**). Dismiss any system messages regarding SD card formatting because *Etcher* will do this for you.

Step 2

Insert the SD card into your Raspberry Pi, connect your power supply to the microcomputer, and let it boot. The Pi/Pi-Star will attempt to log into Wi-Fi, but after a few minutes, it will proceed to create its own hotspot.

When the hotspot installation has finished, you need to direct your PC to connect to it rather than your home Wi-Fi. Go to the Wi-Fi settings on your PC, choose **PI-STAR**, and select **CONNECT**. Enter "raspberry" when a password is requested.

Set the node type to **PUBLIC** if other radios with different call signs will be using this hotspot. You most likely can leave the APRS Host set to the default, but look at the manual for more information. Finally, set the time zone and language to your requirements.

Next, you need to connect to the Pi-Star portal on the Pi-Star. To do this, open your web browser on your PC, type "192.168.50.1" in the address bar, and press **ENTER.** You will soon see the Pi-Star Dashboard (see Figure 2).

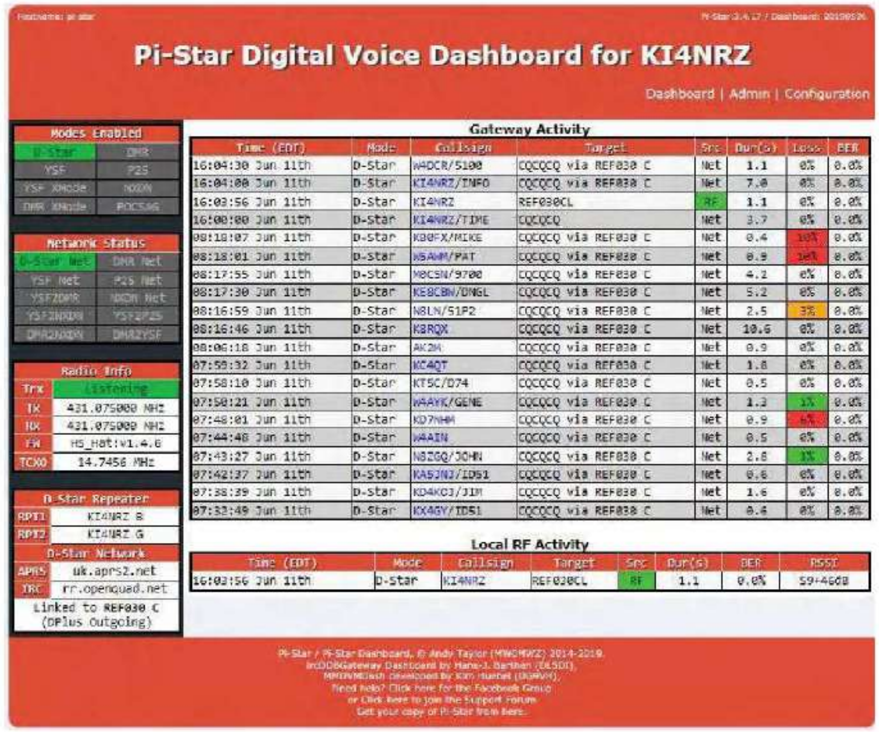


Figure 2 — The Pi-Star dashboard.

To configure Pi-Star to work with your Pi/PiHat, select the **CONFIGURATION** button in the top right (if a setting is not mentioned, the default will work). Select **APPLY CHANGES** below each panel to update changes to that specific panel.

On the **CONTROL SOFTWARE** panel (see Figure 3), select **MMDVM HOST** and **SIMPLEX MODE**.

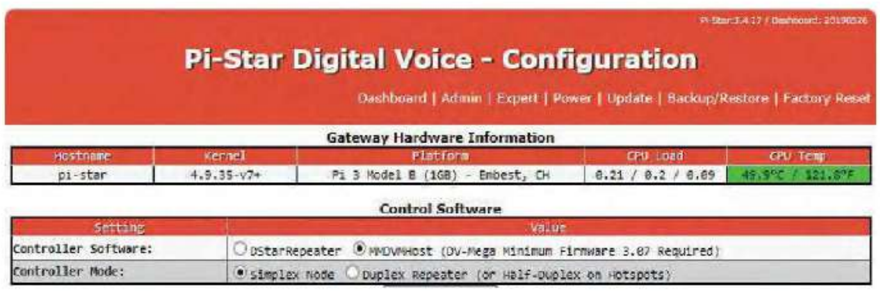


Figure 3 — The **CONTROL SOFTWARE** panel.

On the **MMDVM HOST CONFIGURATION** panel (see Figure 4), turn on D-STAR mode. On the Display Type, press the down arrow and select **OLED** to turn on the PiHat OLED display.

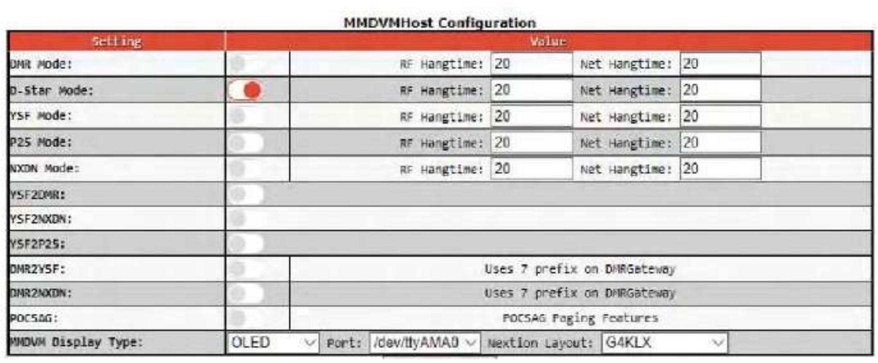


Figure 4 — The **MMDVM HOST CONFIGURATION** panel.

On the **GENERAL CONFIGURATION** panel (see Figure 5), set the node call sign to your D-STAR call sign.

Step 3

Set your D-STAR radio frequency to whatever you will use to communicate with the hotspot once it is configured. This frequency setting is for communication between the Pi-Star and the local radio (most PiStar hats only communicate on UHF).

Set up latitude and longitude for your location. Set your town and country, and set the radio/modem type to **STM32-DVM / MMDVM_HS — RASPBERRY PIHAT (GPIO)** via the dropdown selection. This is the setting for the PiHat I used. If you are working with a different PiHat, check the documents that come with it.

Step 4

In the **D-STAR CONFIGURATION** panel (see Figure 6), set the RPT1 call sign to your call sign if it wasn't automatically carried here from a previous entry. Enter a "B" for UHF, unless you have a PiHat that works in VHF, in which case enter a "C." The RPT2 will be generated automatically, and you'll note that "G" is for "gateway." You can set up a default reflector on power up if you wish. The **FIREWALL CONFIGURATION** panel should default to the selections shown in Figure 7.

The **WIRELESS CONFIGURATION** panel (see Figure 8) configures the Pi-Star to work on your home Wi-Fi. Select "Configure Wi-Fi" and input your home Wi-Fi SSID and password. Turn the P-Star power off and then on. When you do, the Pi-Star will connect to your Wi-Fi. You can now go back to your PC and change its Wi-Fi settings to connect to your home network.

Finally, you must determine the Pi-Star IP address that was assigned by your router. While the Pi-Star OLED display will eventually display the Wi-Fi IP address, you can download the *Advanced IP Scanner* (**www.advanced-ip-scanner.com**) and run it to find the new address. Once you have determined the Pi-Star IP address, enter it into your browser, and you will be able to connect to Pi-Star over your local Wi-Fi in case you ever need to access it to make changes.

This process should be easily reproduceable by most hams. For additional help, go to the **www.arrl.org/QST-in-Depth** web page for a radio/D-STAR hotspot programming example.

General Configuration

Setting	Value	
Hostname:	pi-star	Do not add suffixes such as .local
Node Callsign:	KI4NRZ	
Radio Frequency:	431.075.000	MHz
Latitude:	34.93	degrees (positive value for North, negative for South)
Longitude:	-83.86	degrees (positive value for East, negative for West)
Town:	Young Harris	
Country:	USA	
URL:	http://www.qrz.com/db/KI4NRZ	◉ Auto ○ Manual
Radio/Modem Type:	STM32-DVM / MMDVM_HS - Raspberry Pi Hat (GPIO)	
Node Type:	○ Private ◉ Public	
APRS Host:	uk.aprs2.net	
System Time Zone:	America/New_York	
Dashboard Language:	english_us	

Figure 5 — The **GENERAL CONFIGURATION** panel.

D-Star Configuration

Setting	Value	
RPT1 Callsign:	KI4NRZ B	
RPT2 Callsign:	KI4NRZ G	
Remote Password:	•••••••••	
Default Reflector:	REF030 C	○ Startup ◉ Manual
ircDDBGateway Language:	English_(US)	
Time Announcements:	(on)	
Use DPlus for XRF:	(off)	Note: Update Required if changed

Figure 6 — The **D-STAR CONFIGURATION** panel.

Firewall Configuration

Setting	Value	
Dashboard Access:	◉ Private ○ Public	
ircDDBGateway Remote:	◉ Private ○ Public	
SSH Access:	◉ Private ○ Public	
Auto AP:	◉ On ○ Off	Note: Reboot Required if changed
uPNP:	◉ On ○ Off	

Figure 7 — The **FIREWALL CONFIGURATION** panel. The default values work as shown.

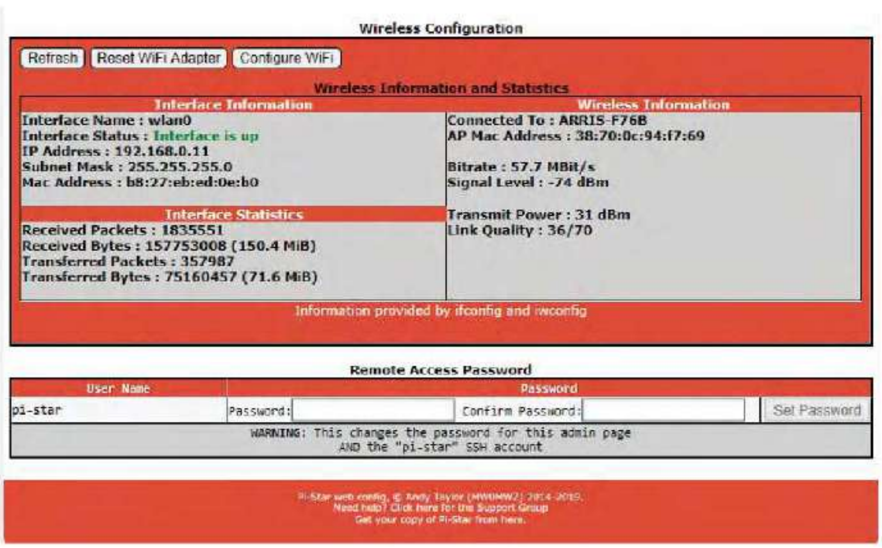
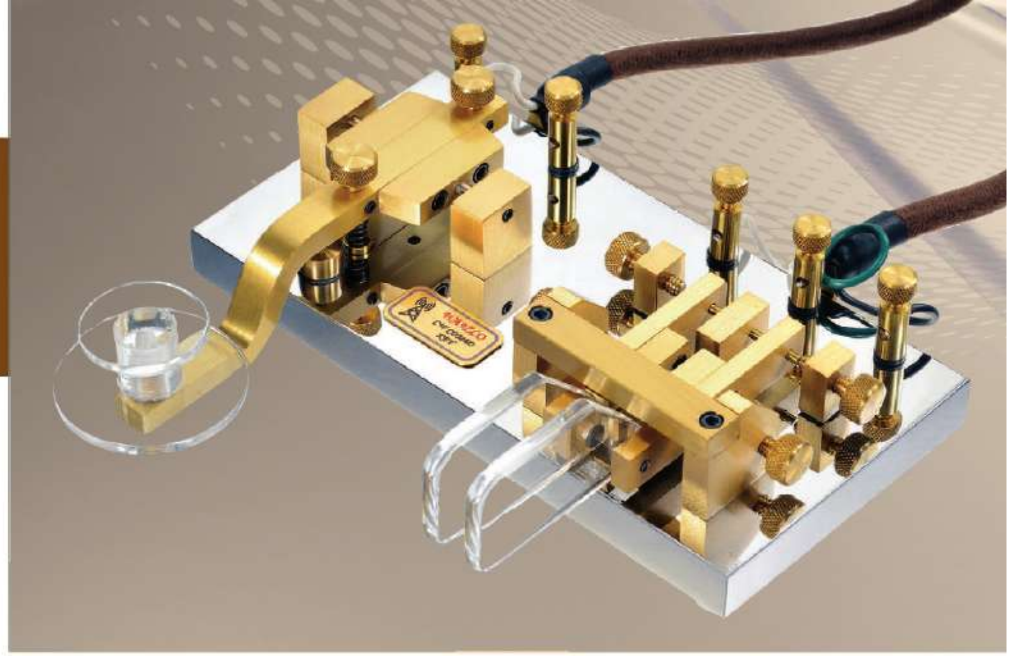


Figure 8 — The **WIRELESS CONFIGURATION** panel.

Bob Wilton, KF5TPQ, holds a General-class license and has been licensed since January 2013. He attended a technical college where he studied electronic technology, after which he worked for 36 years in the large computer industry providing on-site customer technical support and engineering design and development support. Bob retired in 2011 and is now the ARES Emergency Coordinator for Towns County, Georgia, as well as the Secretary for the Mountain Amateur Radio Club in Hiawassee, Georgia. He enjoys working HF SSB DX as well as multiple digital modes, including PSK, JT9, JT65, FT8, and WinLink. You can contact Bob at **bmwilton@live.com**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Fabricate this dual-key design in your home workshop.



CW Combo Key

Marc Alan Winzenried, WA9ZCO

This Combo Key (dual-key) design is suitable for operating transceivers like the Icom IC-7610, with a straight key plugged into the rear key port and a paddle plugged into the front port, allowing on-the-fly operation of both keys without the need for transceiver reconfiguration (see the lead image). The design is compact, and maximizes key stability in a small size.

The key features dual-key functionality, compact size, and heavy base weight for operational stability. It has single-hand adjustments without the need to adjust locking nuts, has minimal adjustment backlash, and adjustable tension holding. Only a summary and safety precautions appear here. Detailed construction information, mechanical drawings, a materials list, and additional images can be found on the **www.arrl.org/QST-in-Depth** web page, as can the design drawings and *Design CAD* files.

Figure 1 — A drill press used as a milling fixture.

Although there is some milling used for fabrication of some components, I did not use a milling machine.

Tools

You will need a multispeed drill press (see Figure 1, shown milling the base), a belt sander with a fixed stand, and a right angle grinder with thin ferrous metal cutting disk. You will also need an X/Y table with a vise (**www.harborfreight.com**), and a table saw with an aluminum metal cutting blade.

Also needed are a small hobby metal chop saw, a Dremel tool with metal cutting discs, a router with wood-type router bits, and a small hydraulic jack — shown in use bending the key arm in Figure 2. A half-inch variable speed drill, wire gauge drill set, modified wire gauge drills for brass cutting, a quarter-inch ferrous metal end mill, and a quarter-inch non-ferrous metal end mill are also useful.

Key Design

I designed components using a very early version of *Design CAD*, starting with the functional components first and then the mounting components. I then fabricated parts. I first assembled the key on the unfinished steel base to check the design concept, and then disassembled it for final finishing. Although there is some milling used for fabrication of some components, I did not use a milling machine. To stay with the concept of using commonly available and affordable tools, I mounted an X/Y table vise to the base of the drill press and installed a quarter-inch end mill in the drill press chuck (see Figure 1).

Figure 2 — A hydraulic jack mounted in a fixture for armature bending.

Steel Material Fabrication

Cut the steel key base using a right angle grinder with a thin metal cutting disk. Follow all safety precautions, including safety glasses, hearing protection, heavy clothing, and appropriate gloves. Cutting steel with a grinder and a cutting disk produces sparks that can ignite combustible materials, so do this process in a safe area, free of all combustibles. Use a belt sander mounted in a rigid stand, and a heavy-duty metal cutting belt in the sizing and pre-polishing steps. The threaded holes were hand tapped using a tap with the appropriate lubrication cutting fluid.

Brass Material Fabrication

I cut all of the brass components on a table saw with an aluminum-cutting blade installed. I used a 7½-inch Milwaukee aluminum cutting blade, as shown in Figure 3, but other non-ferrous metal cutting blades are available. Cutting brass at the slowest speed possible did not produce any sparks.

Figure 3 — A brass sawing table with an aluminum saw blade at right.

Figure 4 — A rough sanding fixture.

I used a double-fluted end mill intended for aluminum, but it works well on brass. Drilling brass is different than drilling steel, so I used modified drill bits specific to brass drilling.

Finish the brass components using the belt sander (see Figure 4) and a hand-sanding block. Hand tap the threaded holes using standard taps with the appropriate tap lubrication cutting fluid. I made a tap alignment block from a small scrap block of brass with the appropriate tap clearance hole drilled.

Plastic Material Fabrication

I cut most of the acrylic plastic parts using the table saw with an aluminum cutting blade. Cut circular parts using hole saws with a wood guide block. Cut the paddle handles using the table saw, and the front radius corners using a table-mounted wood router and a wood radius cutter bit with a bearing guide. Radius-cut the edges of the paddle handles using a 1⁄16-inch wood radius cutting bit that also has a bearing guide.

Sand all plastic edges in steps using sanding paper from 180 grit to 3,000 grit. Once you've finished sanding the edges of the plastic, polish the edges using the Novus #2 and 3 plastic scratch remover products. Holes drilled in the plastic are best done using the brass modified drill bits. Thread the holes with a hand tap without using any cutting fluid. Align the tap using an alignment block.

Combo Key Base Fabrication

Cut the base from a 12 × ½ × 3 inch rectangular cold rolled steel bar stock using a right angle grinder with a metal cutoff wheel. Sand and pre-polish the cut base to the finished size using the belt sander mounted in a fixed stand. Mark and drill all holes using a standard drill press. Counter-sink all socket head screws on the base bottom side to recess the screw heads (see Figure 1). Mill the conductor slots on the key base bottom side using the tooling, as described on the *QST* in Depth page.

Assemble the complete key and test for operation. Once the key is fully operational, disassemble the base and have it chrome plated by a local plating shop. Then re-assemble the key and add the four self-adhesive rubber pads to the base bottom corners.

Straight Key Fabrication and Assembly

For the bending process, I built a jig from steel straps to hold a small common hydraulic jack (see Figure 2). My jig was welded, but the jig can be fabricated without a welder. Use safety glasses during the bending process. I used a full-scale print of the armature as a template to confirm the correct bends of the armature. The armature could be inserted in the jig backwards to correct an over-bent armature. Roughly sand the armature sides with a belt sander to remove the side bend-outs so the armature can sit square for drilling the holes for the tension screws, axle, and side supports. Trim the armature to the finished length using the table saw. Details of the straight key assembly are on the *QST* in Depth page.

Once the key is fully operational, disassemble the base and have it chrome plated by a local plating shop.

Paddle Key Fabrication and Assembly

The paddle armatures are an assembly of four parts that include the main support, axle support, axle, and the contact pin. Cut the two main paddle armatures from 3⁄16 × 3⁄8 inch brass bar stock using the table saw, and roughly sand using the fix-mounted belt sander. Both left and right main paddle armatures are symmetrically identical, so the same operations apply to both pieces. Again, specific detailed instructions are on the *QST* in Depth web page.

Cut two axle supports from brass bar stock, and roughly sand. Both left and right axle supports are symmetrically identical. Cut two brass contact rods from round brass rod stock. Cut the armature axle to length from a stainless-steel standard stock rod using a Dremel-mounted metal cut-off disk, and polish each end using the drill press.

Cut two base side supports from brass bar stock. Both base side supports are symmetrically identical, so the same operations apply to both pieces. Mill the top bearing support bar notches and the back angle using the X/Y table vise on the drill press.

Cut two base contact supports from brass bar stock using the table saw and roughly sand. Both base contact supports are symmetrically identical. Cut the main support center stop from brass bar stock and roughly sand.

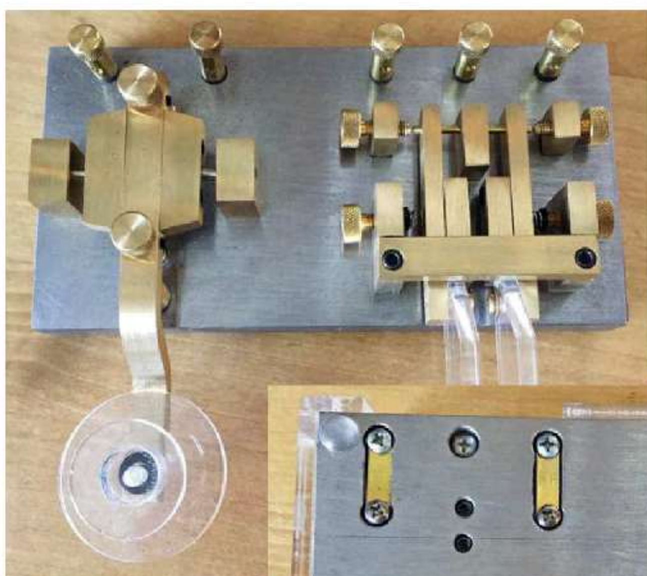
Cut the upper bearing support bar from brass bar stock, and roughly sand. Cut three brass terminal posts from a standard round tube brass stock. Cut two brass contact rods from round brass rod stock. Drill one end of each piece with a small dimple using a drill-centering jig. Fill the dimple hole with rosin flux, and silver solder the end. Place the part in the drill press chuck for finish sizing and polishing. Install the completed contacts in the end of the two paddle armatures and hold in place with locking setscrews.

Fabricate the two contact strips from the brass strips that were cut using the hobby metal chop saw. Radius grind both ends, remove burrs using the belt sander, and drill clearance holes in each end. Cover the non-contact part of the strip with heat insulating tape.

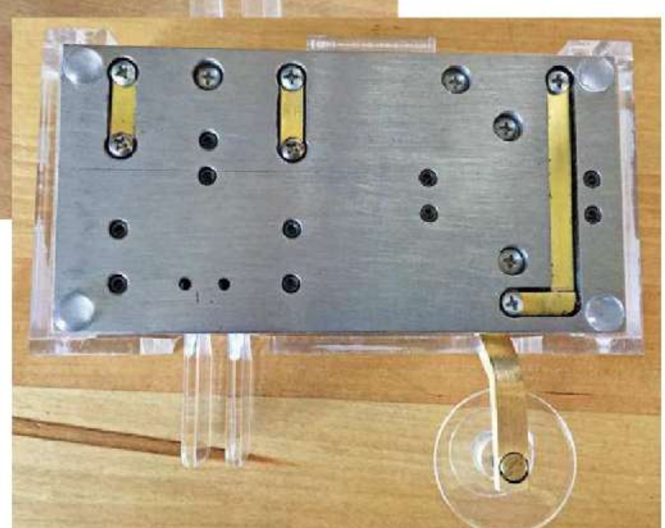
Install the three terminal brass thumbscrews. Modify the two spring adjustment thumbscrews to accommodate shoulder washers used to center the spring. The two nuts on each thumbscrew are locked to each other exposing 1⁄16 inch of the thread. Insert this into a portable drill chuck, and turn while filing until the shoulder washer fits to the end of the thumbscrew. Remove the nuts on the thumbscrew, and realign the thumbscrew threads after filing.

Paddle Key Assembly

Both paddle armature assemblies are symmetrically identical with the exception of the axle orientation, which is adjusted after installation. Mount the axle supports to the main paddle armature supports using two socket head steel screws in each axle support. Do not tighten yet. Clamp the assembly in a vise with pads, and tighten the socket head screws. Drill the



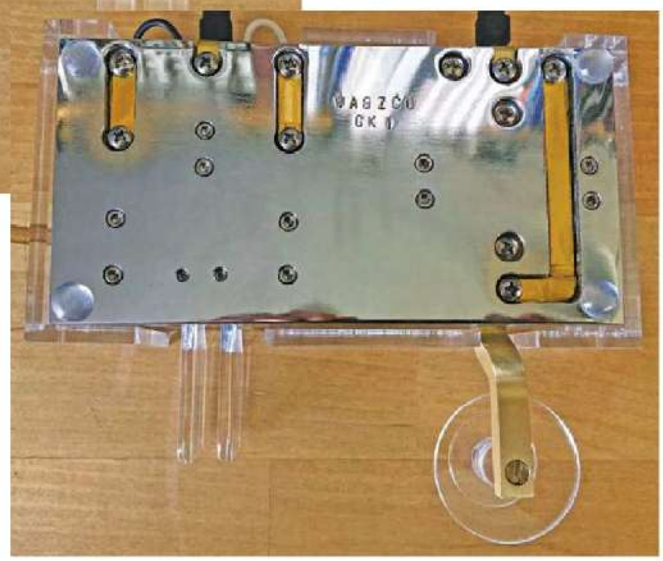
▲**Figure 5** — The top view of the key before final finish.



▶**Figure 6** — The bottom of the key before final finish.

◀ **Figure 7** — The top view of the key after final finish.

▼ **Figure 8** — The bottom of the key after final finish.



I cut most of the acrylic plastic parts using the table saw with an aluminum cutting blade.

spring blind hole in the axle supports using the main paddle armature spring clearance hole as a guide. This assures the axle support block spring blind hole is aligned with the main paddle armature spring clearance hole. Install the axles, and install and lightly tighten the locking setscrew. Setscrews will be fully tightened once the armature assembly height adjustments are completed. Install the contacts with the silver soldered end facing the same direction as the spring open hole. Install and lightly tighten the contact locking setscrew. Fully tighten the setscrews once the armature assembly horizontal position adjustments are completed.

Install the spring adjustment thumbscrew in each of the base side supports. Cut two 1/16-inch nylon pieces from 1/16-inch weed cutter line, and insert each piece in the rear tapped hole of each side support tension adjustment hole. Install two tension adjustment setscrews in the rear of each side support tension adjustment hole, and adjust for best tension control.

The assembled side supports are installed on the base using four socket head screws. These screws are not tightened until final assembly.

Install the assembled contact supports on the base. Install a thumbscrew in each of the three terminal posts. Install 1/16-inch nylon and setscrews in both contact supports like in the side supports. Install the other two non-grounded terminal posts. Align the terminal wire holes and tighten the screws. Align the base contact supports and tighten the screws. Install the base center stop support on the base using socket head screws and tighten.

Install two setscrews on the base from the bottom. These are used for adjusting the paddle axle vertical play. Insert a single roller bearing in each of the axle base top holes. Install the shoulder washer on each spring adjust thumbscrew. Insert a single roller bearing in each of the axle upper bearing support bar blind holes. Insert the springs in the paddle's

Figure 9 — The Combo Key in its wooden box.

main armature assemblies and install the assemblies with the lower axle inserted into the base axle holes and the spring aligned into the thumbscrew shoulder washers.

Install the upper bearing bar with the two socket head screws and tighten. Tighten the four side support socket head screws. Adjust the lower paddle free play with the axle setscrews located under the base. Once adjusted, install another setscrew on the underside of the base to lock the free play adjustment setscrew. Adjust the paddle's main assembly for alignment to the contact thumbscrews by the axle-locking setscrew. This adjustment requires removal of the upper bearing support bar and removal of the paddle assembly. The paddle assembly contact rods are adjusted to provide best alignment of the front paddles.

Testing and Finishing

Figure 5 shows a top view of the unfinished key, and Figure 6 shows a bottom view. Adjust and test both the straight key and the paddle key to confirm operation. Then disassemble the keys so all parts can receive final finishing. Final finishing includes hand sanding and clear coating of all brass components.

After final finishing, re-assemble and re-adjust the keys. Figure 7 shows the top, and Figure 8 shows the bottom of the finished and polished Combo Key. I also fabricated a wooden case to store the Combo Key (see Figure 9).

Marc Alan Winzenried, WA9ZCO, was first licensed in 1968 and now holds an Amateur Advanced-class license. He retired from a career in industrial machine control design, writing control system software and managing projects. Marc graduated with an associate's degree in electronics. He has designed and home-built most of his equipment, including QRP transceivers, panels, antennas, Arduino projects, and solar systems. A recent project includes an NEC-compliant amateur radio station off-grid solar backup power system. You can reach Marc at **wa9zco@bayland.net**.

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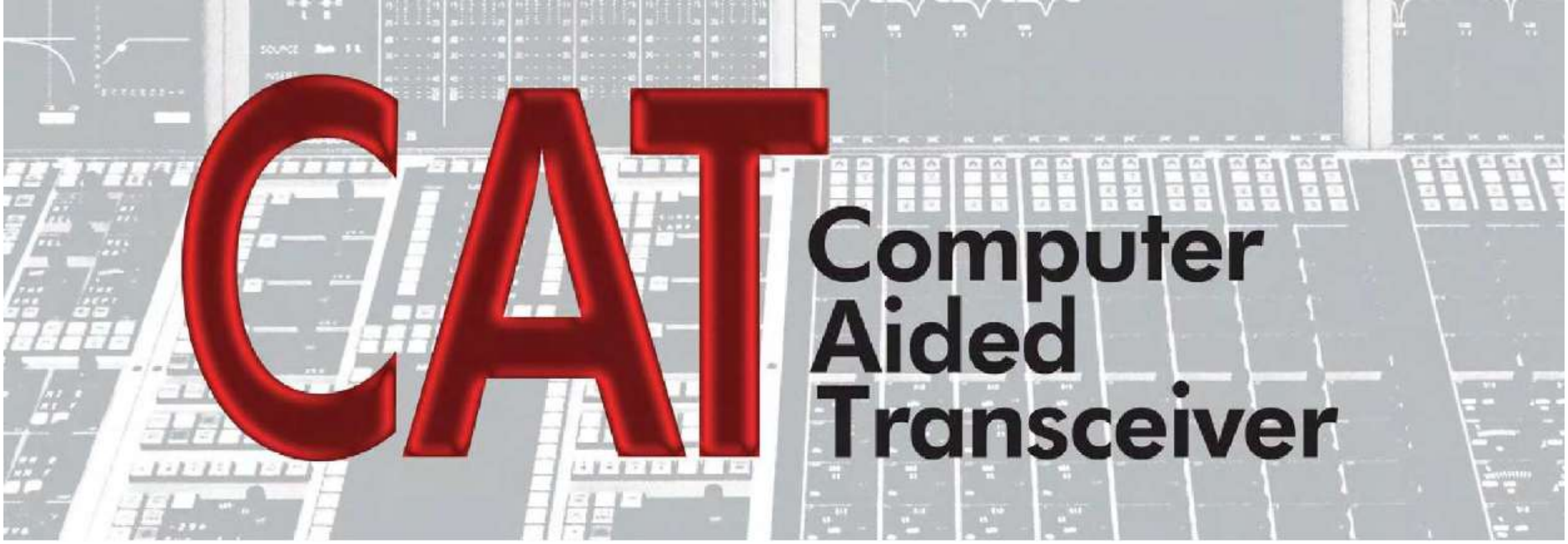
Feedback

- The article "Comparing Mobile/Portable Antennas of 20 Meters" by Ulrich Rohde, N1UL, published in the January 2020 *QST* contained a few typographical errors. The company name should be spelled Rohde & Schwarz in the caption of the lead image; the call sign mentioned on page 41 should be S51DX, and the author's email address should have been listed as **dr.ulrich.l.rohde@gmail.com**.



CAT Computer Aided Transceiver

Steve Ford, WB8IMY

Controlling your transceiver from your station computer is hardly new, but in recent years it has become quite popular, particularly for those who enjoy operating their stations remotely. Thanks to CAT — Computer Aided Transceiver — you can operate a distant transceiver as though you were sitting directly in front of it. You simply access the station computer through the internet and allow the host software and CAT to do the rest.

But beyond remote-control applications, CAT is gaining favor simply because it is so convenient. With CAT control, your logging software always "knows" your frequency and operating mode — all you have to do is enter the call sign of the station you contacted. If you use *WSJT-X* for FT8 and other modes, the software will use CAT to change frequencies with just a mouse click on a drop-down menu (it can even hop from band to band automatically when operating WSPR). The same is true for many other CAT-enabled applications.

Before we dive deeper into CAT, however, it is important to point out that CAT control is not necessarily the same as transmit/receive keying you might use through an interface for, say, CW or digital operating. The only "control" going on in those activities is whether the transceiver is transmitting or receiving; your computer is not communicating with the radio in the same sense that it does with CAT.

The Official CAT

The CAT acronym has become generic these days and is often used to mean any type of transceiver control. However, there is only one "true" CAT.

By definition, CAT is a control interface based on the RS-232 data standard. If you've been around personal computers for a while, the standard should be familiar. Depending upon the application, CAT is usually a point-to-point protocol: a single computer controlling a single radio. Many CAT systems rely on ASCII data and the "meaning" of a given ASCII character is particular to the brand of the radio you are attempting to control.

This means that the software must send the specific ASCII characters the radio expects to see. By the same token, the radio will respond to the software with specific ASCII characters. Think of it as your computer and transceiver being required to correctly speak the same language, although computers are not nearly as forgiving as human brains. I can fumble through Spanish and make myself understood in a simple exchange, but that's not sufficient in the computer world. Even the slightest error in "pronunciation" over a CAT line will totally disrupt the communication.

Setting up computer control of a transceiver is easier than you think.

When you reach for the radio and change frequencies, for example, your radio will respond by sending data to the computer to say, in effect, "This is my new frequency." But if the data isn't what the software running in your station computer expects to see, the computer will reply with something akin to "Huh?" and display nothing or possibly even gibberish on your monitor.

Not only do your computer and transceiver need to speak the same language, they must do so at the same speed and in the same data format. The signaling rate — expressed in *baud* — must be the same. The number of *data bits* and *stop bits* must also match. This is why every piece of CAT-enabled software includes a menu in which you establish these parameters.

Icom CI-V

Icom's version of the CAT interface is known as CI-V. CI means "Communication Interface" and V is the Roman numeral 5 — Computer Interface Five.

CI-V is also based on RS-232, but it is a serial "one-wire" protocol. Unlike many CAT implementations, CI-V allows control of multiple radios on a single communications line. By using CSMA/CD (carrier sense, multiple access, collision detection), multiple radios can avoid using the communications interface at the same time, and they can detect when a collision occurs and will retransmit the data. If you work in Information Technology, you'll recognize this as the same technique used in 10BASE2 Ethernet.

With CI-V, each radio has an address and the computer can communicate with any of the radios on the CI-V bus by using their unique addresses. The CI-V protocol allows for tuning the radio, changing modes, selecting memory channels, and other functions. CI-V generally treats the RS-232 data as bytes and references commands using their hexadecimal values.

Figure 1 — Windows 10 Device Manager. This is where you can determine how Windows has assigned your virtual COM ports.

CAT Over TCP/IP

In recent years, CAT has also been implemented over TCP/IP (an internet standard communications protocol pair), often for use with software-defined radios. For example, in the FlexRadio Systems *SmartSDR* program, a TCP/IP port can be added that responds to CAT commands. So, the base protocol remains the same, but the communications transport mechanism is TCP/IP.

The FlexRadio *SmartSDR* approach to CAT supports integration with software that was designed for more traditional radios. This means that your logging program should communicate smoothly with a FlexRadio transceiver, but may be somewhat limited in what it can do. After all, the CAT standard didn't anticipate that we would see the day when a single transceiver would be able to receive on several frequencies simultaneously.

Connecting with CAT

Most modern transceivers support CAT control and they do it through a cable connected between the radio and your computer, or between the radio and a hardware interface that supports CAT. In years past, making the physical connections could be complicated, depending on the types of connectors needed. Thanks to the advent of USB, however, it is much easier today.

If you are using a USB interface that supports CAT, a single cable will connect the interface to your computer. Another cable, or set of cables, connects the interface to your transceiver. If you are blessed with owning a radio that has its interfacing circuitry built-in, you may need only one or perhaps two USB cables between your computer and radio.

In either case, when you plug in the USB cables, Windows (the operating system used in the vast majority of stations) will recognize the device — your interface or your radio — and will automatically set up one or more virtual COM ports. It will assign specific numbers to each port and you'll need to know these numbers before you attempt to configure your software.

In Windows 10, click on **SETTINGS** in the **START** menu. Now type "Device Manager" in the search window. Windows will display the search result; click on it.

Soon you will see a list of devices similar to what you see in Figure 1. Click the arrow beside **PORTS (COM & LPT)** and you will be presented with a list of all ports presently in use. The port for your radio or interface may be labeled with a name you may not recognize.

If you are unsure, unplug the USB cable and notice which port suddenly vanishes. Plug the cable back in and write down the port number when it reappears.

The image in Figure 1 was taken from my station computer. My transceiver is an Icom IC-7300. When I plugged in the USB cable between the '7300 and my computer, Windows assigned it to virtual COM port 9. You'll see it labeled in the port list as "Silicon Labs CP210x USB to UART Bridge (COM 9)."

I can use this connection to fully control the IC-7300, but I do some peculiar things with software and I needed to run CAT on a separate line. So, to meet my needs, I purchased a USB CI-V interface on eBay for about $30 and I have it connected separately. Windows assigned it to COM 3 and labeled it accordingly. You'll see it on the list as well.

Now let's turn to your software. In this example, I will use the popular *WSJT-X* application. Other programs will display different menus, but the fundamentals are the same.

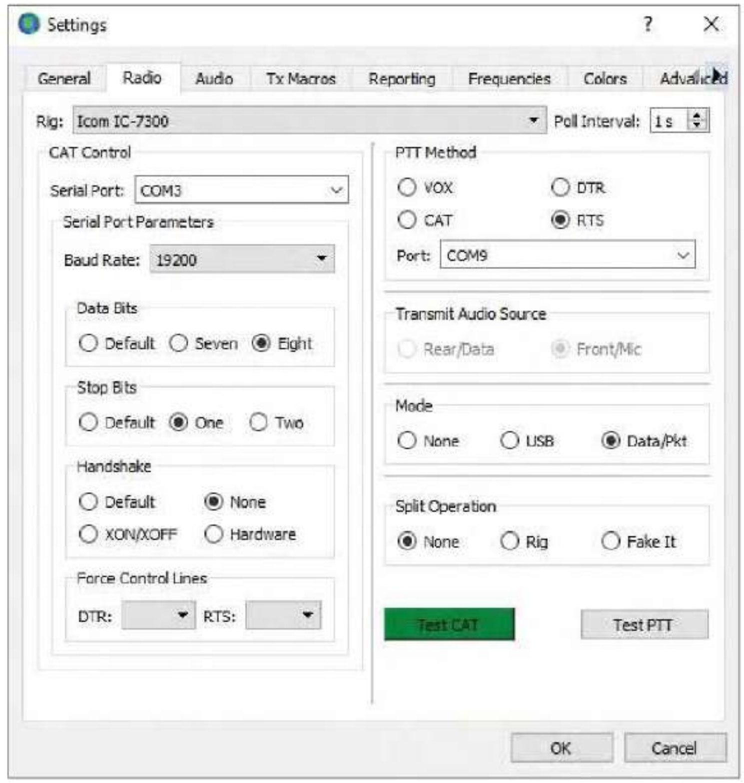


Figure 2 — The radio setup menu in *WSJT-X*. For CAT control, we're interested in the choices on the left-hand side of the menu.

Figure 2 is the *WSJT-X* radio settings menu. Look at the top of the menu and you will see that I have selected the IC-7300 from the list of radios. By doing so, I've told *WSJT-X* that it needs to use the proper language to communicate with my transceiver. In other words, I've asked *WSJT-X* to "speak" the IC-7300 CAT dialect.

On the left-hand side, you'll see an area labeled **CAT Control**. This is where I set the parameters necessary to communicate with my radio. From the top down, the first selection is the serial port. For me, that is COM 3.

The next descending rung on the ladder is the baud rate. All transceivers that support CAT have a default baud rate — a rate that is set at the factory. Look in your manual and find the default rate. You can always change it, of course. If you are using an older radio, or a used radio, the rate may have changed. Access the data rate menu in the radio and check to be sure.

In my case, I have set the rate to 19,200 baud. That is much faster than most operators need, but once again, I have odd requirements. If you plan to do a lot of data handling over the line, such as transferring a

Matching the Data Parameters

Aside from speaking the command dialect your transceiver understands, successful CAT communication requires matching these four data parameters.

Baud Rate: Baud is the unit for the symbol or modulation rate in symbols or pulses per second. So, 9,600 baud means 9,600 symbols per second.

Data Bits: The number of bits used to represent one data character. Eight bits are the norm in CAT communication.

Stop Bits: In CAT communication, a *start* signal tells the receiving device (your radio or your computer) to get ready for new data. You won't be asked to specify this in your software setup. However, you *do* have to choose the number of stop bits. These bits essentially execute a reset so a new data sequence can begin. In most instances, one stop bit is all that is needed.

Parity: A simple form of error checking. When data is transferred electronically, it's not uncommon for bits to "flip" — change from a 1 to a 0, or vice versa. A parity check can detect these errors. Let's say you have a binary sequence that is using "even" parity. In that case, a parity check counts the total number of ones and if the sum is not even, that means an error is likely to have occurred. If you're asked to set parity, your choices are typically odd, even, or none at all. For CAT, the choice is often "none."

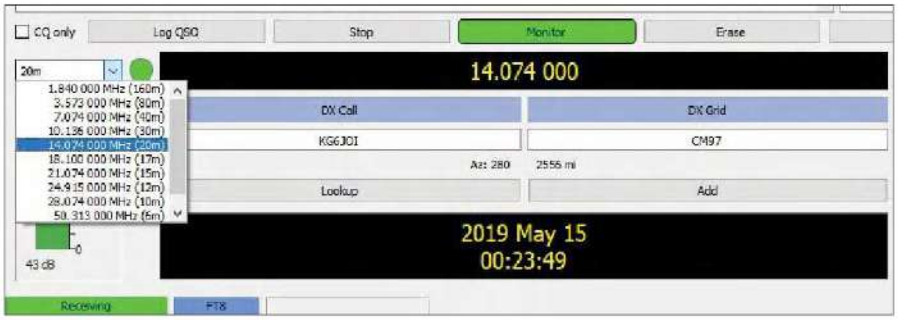


Figure 3 — With *WSJT-X* communicating with my transceiver, I can change bands and frequencies with just a click.

panoramic display from your transceiver to your computer, faster is better. Your manual will usually specify an appropriate rate.

Finally, below the data rate selection, I have set 8 bits, 1 stop bit, and no handshaking (handshaking isn't needed in most CAT systems). This is the standard CAT configuration although, once again, consult your transceiver manual.

With *WSJT-X* communicating with my transceiver, I can change frequencies — and switch to the correct frequencies in each band — by just clicking my mouse on the drop-down menu (see Figure 3).

I've provided another example in Figure 4. This is the CAT menu used by N3FJP's *Amateur Contact Log* software. Notice that the COM port, the data rate, the number of data bits, and the number of stop bits are the same. *Amateur Contact Log* gives you the ability to select *parity* error checking. You'll usually set this to "none" for CAT applications.

Amateur Contact Log also allows you to set the polling rate, which is a parameter that dictates how often the software taps your transceiver on the shoulder and requests an update, so to speak. Every 2 seconds is enough for me.

The CAT is in Control

There is a certain satisfaction in seeing your operating frequency suddenly displayed in your software. And as you spin the VFO knob, the software display changes as well. Your computer and radio are carrying on a friendly conversation and all is well with the world.

CAT may seem like a luxury to some, but once you've got it up and running, I'm willing to bet you will never go back.

Steve Ford, WB8IMY, is the Editor of *QST*. You can reach him at **sford@arrl.org**.

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Figure 4 — The **Rig Interface Setup** menu in N3FJP's *Amateur Contact Log* software.

An SWR-Shifting T

If your transmitter or amplifier balks at a mismatch at a specific frequency, here's a simple fix.

The SWR-Shifting **T** at the station end of the transmission line.

Bill Conwell, K2PO

Any feed-line mismatch can be brought to a 1:1 SWR with a single shunt capacitor, provided its value and the location where it bridges the coaxial center and shield conductors is chosen correctly. This is because there are two locations at every half-wave along a mismatched feed line where the impedance is exactly 50 Ω in parallel with a reactive component. By extending or shortening the coax so that one of these locations is at the transmitter-end of the coax, a counter-reactive shunt component can be applied using a coaxial T connector (see the lead photo), thus bringing the SWR to 1:1. The shunt component can be unscrewed when desired to restore the antenna to its original tuning.

Using the Smith Chart

The Smith chart, invented by Phillip Smith, is a tool that enables us to determine the value of the necessary reactive component and its transmission line location to achieve a match — in my case, transforming a 4:1 SWR in the 80-meter RTTY band to 1:1.[1, 2]

To determine coax extension and shunt reactance with the Smith chart, we start by using an antenna analyzer to measure the impedance the feed line presents to the rig at the frequency of interest, and then *normalizing* it to plot on the Smith chart. Normalizing simply involves dividing the resistive and reactive parts of the measured impedance by the transmission-line impedance. The resistive axis of the Smith chart (see Figure 1) is the only straight line on the chart. Its normalized middle value is 1 Ω. To the left side, the values approach 0 Ω; to the right side, the values approach infinity. The reactive axis of the Smith chart is the outer perimeter. The normalized value at the top center is 1 Ω of inductive reactance, and the value at the bottom center is 1 Ω of capacitive reactance. As with the resistive axis, values to one side of the chart approach zero, and values to the other side approach infinity.

The 50 Ω coax from my very short, 80-meter coil-loaded rotatable dipole presented an impedance of 135 – *j*90 Ω to my rig at 3580 kHz (the "– *j*" indicates a capacitive reactance). 135 – *j*90 normalizes to 2.7 – *j*1.8 and is plotted at point Z in Figure 1.

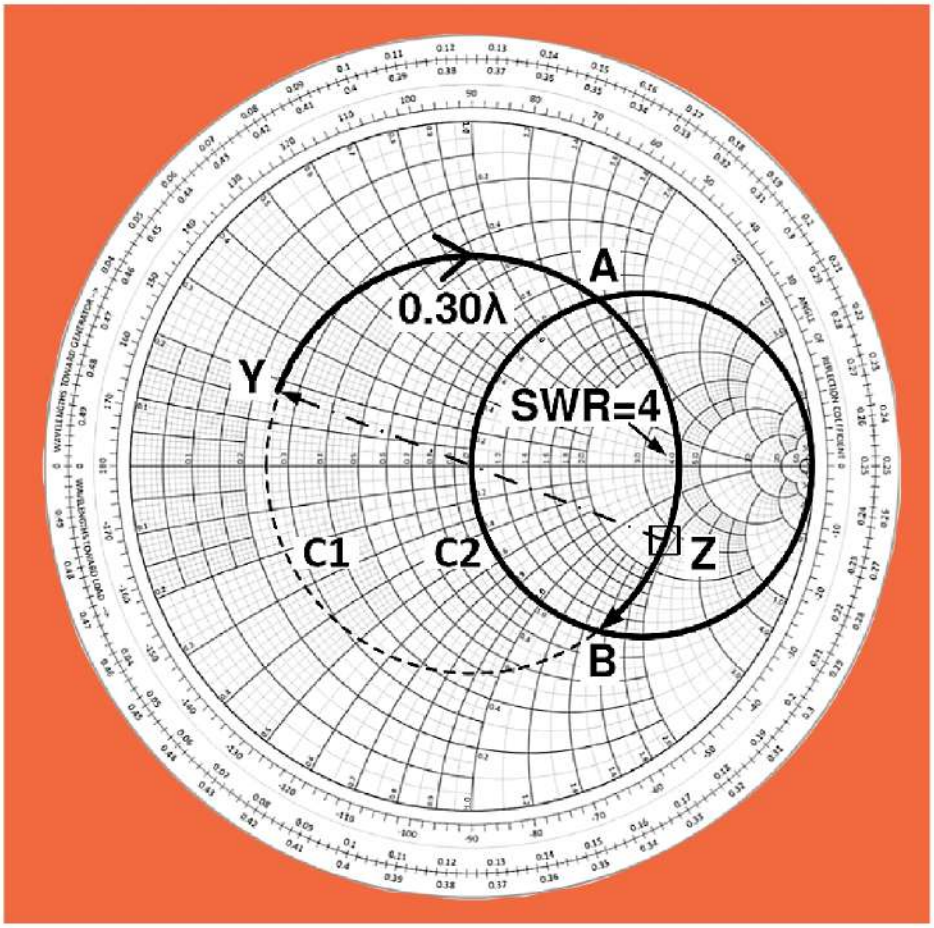

Figure 1 — A Smith chart showing the initial feed-line impedance, Z, and how to determine the value and location of a shunt reactance needed to achieve a 1:1 SWR.

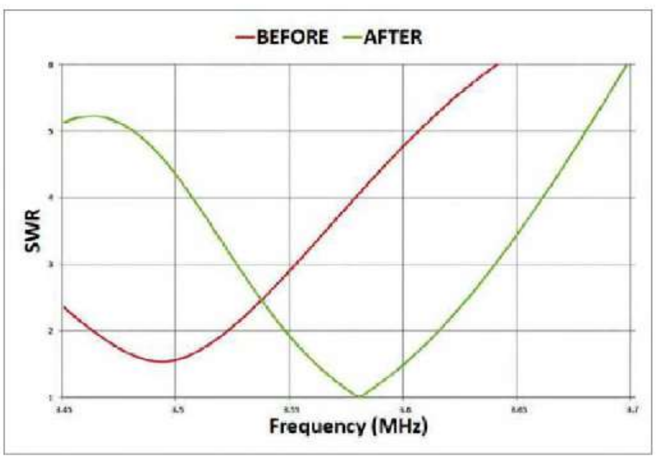

Figure 2 — SWR curves for the author's 80-meter antenna before and after connecting to the SWR-Shifting **T**.

Point Z establishes the radius of SWR circle C1, which is concentric with the center of the chart. The SWR circle traverses all the impedances along a half-wavelength of the coax (the impedances repeat every half-wave). The right-most value where circle C1 crosses the straight, resistive axis indicates the SWR on the coax (4:1 in this case). We want to get from circle C1 to the center of the chart, which represents a perfect 1:1 SWR. I achieved this by extending the coax 0.30 wavelength and using a shunt capacitor of 1,200 pF.

Finding the 1:1 SWR Value

The measured impedance is expressed as a *series* circuit — a resistance in series with a reactance. For a shunt component match, it's easiest to think in terms of a *parallel* circuit, which provides multiple pathways for current to flow. However, impedance calculations get intricate when dealing with parallel circuits. Consider two resistors, R_a and R_b. The series resistance is simply $R_a + R_b$, while the resistance of the two resistors in parallel is $1/[(1 / R_a) + (1 / R_b)]$. Adding the reactance complicates the parallel calculations even more. Therefore, let's dive briefly into the inverted world of admittance.

Admittance is the reciprocal of impedance. To combine two circuit elements in parallel, we simply add their admittance values. We're back to the simplicity of $R_a + R_b$. To convert my starting normalized impedance of $2.7 - j1.8$ to admittance, we draw a line from the starting impedance at point Z, through the center of the chart, across to a point Y where it intersects the SWR circle C1 on the far side. The coordinates of intersection point Y are $0.25 + j0.17$, indicating, respectively, *conductance* and *susceptance* (the complement of reactance) — both measured in normalized *mhos*, the reciprocal unit of ohms and a previous unit of measurement for electrical impedance. (Don't simply invert 2.7 and –1.8 separately.) Admittance point Y and impedance point Z represent the same original mismatch, just in different units.

As we move away from the mismatch on the Smith chart, we move along the SWR circle C1 in a clockwise direction. So, from the original mismatch expressed by its point Y admittance, we advance clockwise along circle C1 by adding feed line until we cross the *unity circle*, labeled C2. This unity circle is the set of all points where the normalized conductance and resistance are 1.0 — i.e., 50 Ω in real resistance terms. (This circle is among the curves pre-printed on the chart.) The SWR circle C1 and the unity circle C2 actually cross at both points A and B, each a shunt-matching opportunity.

The intersection point A, along the top half of the unity circle, is the point where an extended coax can be matched with a shunt inductor. We continue to the other point of intersection, B, along the bottom half of the unity circle, which is the point where extended coax can be matched with a shunt capacitor. Studying the chart coordinates, we find B has normalized admittance coordinates of 1 and –1.35. If we shunt an admittance of 0 + *j*1.35 at point B, the two admittances sum to 1 + *j*0, and we end up at the center of the chart — a perfect match.

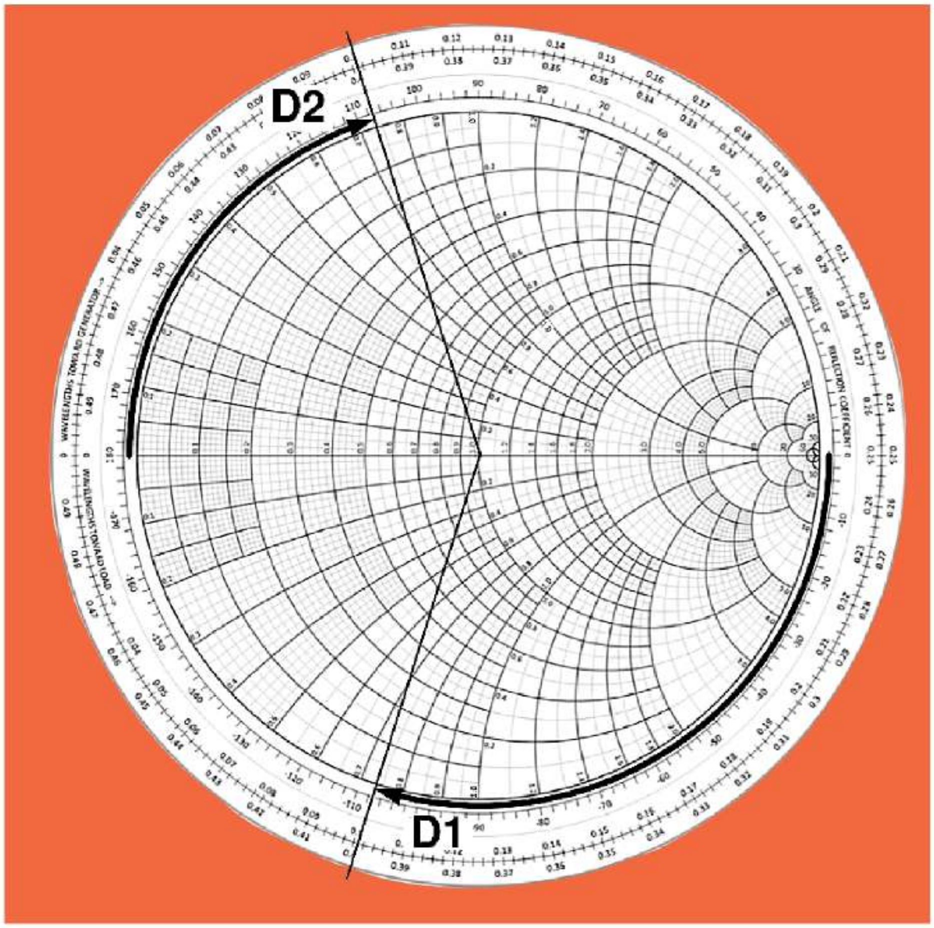

Figure 3 — A Smith chart showing how to determine the length of open-circuited coax (D1) serving as a 37 Ω capacitive reactance, or a short-circuited coax (D2) serving as a 37 Ω inductive reactance.

The needed length of coax extension is the length of the arc from point Y to point B. Using markings on the outer perimeter of the chart, we find this length to be about 0.30 wavelength. I used RG-8X coax with a velocity factor of 0.80. In this coax, a wavelength at 3.58 MHz is (984 × 0.80) / 3.58, or 220 feet. Thus, the extension needed is 66 feet.

In the admittance world, measurements are normalized to a value of 0.02, the reciprocal of 50 Ω to which impedance is normalized. So, the normalized 1.35 value needed for a shunt match indicates a true susceptance of 0.027 mhos. To convert this value to a reactance, we take its reciprocal, and get 37 Ω. This is the value of capacitive reactance that needs to be placed in parallel with the end of the extended coax to achieve a 1:1 SWR.

To convert a reactance of 37 Ω into picofarads, we use $C = 1{,}000{,}000 / 2\pi fX$, where f is the frequency in MHz (3.58), and X is the reactance in ohms (37). This formula indicates a needed capacitor value of 1,200 pF. Silver mica capacitors are well-suited for RF applications due to their low loss and stability.

Coax Length Variations

While most installations will use an added length of coax to put the reactive element at one of the circle-crossing points, it is equally possible to reach points A or B by putting the reactive element closer to the antenna (i.e., moving counterclockwise from point Y). You might have more feed line than you need to reach your rig, which you could shorten for this purpose. Or you could cut the existing coax short of the rig and insert the **T** and the reactive component at the cut location. In my case, instead of extending my coax 0.30 wavelength to apply a shunt capacitive reactance, I could have trimmed it by 0.20 wavelength and put the **T** there.

With the capacitor at a 50 Ω point as part of this matching process, the peak voltage is about 390 V at 1,500 W. A 1,000 V silver mica capacitor from Mouser or Digi-Key is less than $5 and will work well. I mounted the capacitor in a plastic enclosure with a short length of coax and PL-259 to connect to the T, as shown in the lead photo. Figure 2 shows the unmatched and matched SWR curves.

While point B on the bottom half of the Smith chart in Figure 1 indicates where a *capacitor* can be shunted to bring the SWR to 1:1, point A on the top half indicates where an *inductor* can be shunted to bring the SWR to 1:1. Not coincidentally, the magnitude of reactance required is the same as in the capacitive case: 37 Ω. The formula to compute the inductor value from reactance is L (microhenries) = $X / 2\pi f$, where X is the reactance, and f is the frequency in MHz.

The length of coax extension needed is the distance from point Y to point A, or 0.15 wavelength. I could also have achieved a 1:1 match by adding a 0.15-wavelength section of coax, using a T to shunt a 37 Ω inductive reactance (1.6 microhenries) at that point.

Using Coax as a Capacitor or Inductor

You can also use the Smith chart to find a length of open-circuited coax to use as a shunt matching capacitor. We want 37 Ω of capacitive reactance, which normalizes to 0.74 in 50 Ω coax. An open circuit has an impedance of infinite ohms of resistance, so we start at the far-right end of the straight axis in Figure 3. Proceed clockwise until we reach 0.74 on the perimeter reactance axis. That's a distance (D1) of about 0.15 electrical wavelength, or 33 feet in RG-8X, which would be connected to the T adapter in lieu of a 1,200 pF capacitor. Be sure to insulate the open end of the coax because high voltages can be present.

Conversely, a length of shorted coax can serve as a shunt inductor. A shorted coax starts as an impedance of zero ohms resistive, so we start at the far-left end of the straight axis. We proceed clockwise until we reach a normalized impedance of 0.74 on the top perimeter reactance scale. This is a distance (D2) of about 0.10 wavelength, or 22 feet of shorted RG-8X, that can be connected to the T adapter at point A in lieu of a 1.6 microhenry coil.

Conclusion

The SWR-Shifting T described here can create a single frequency matching solution to deal with almost any mismatch. You can happily run your rig on 160 meters using your 40-meter dipole if you want. However, the efficiency of such a system would be poor, as the original mismatch persists on the other side of the reactive component, resulting in SWR-related feed line losses. But for tasks such as tuning a 160-meter or 80-meter antenna system to a different in-band frequency, this arrangement is hard to beat. And when you want to restore the antenna to its original resonance, simply unscrew and remove the shunt reactance. (You may wish to place a bare PL-259 in the unused T socket so the coax center conductor isn't so exposed.)

Some popular software tools capable of doing the calculations described in this article include Richard Dean Straw's, N6BV, *Transmission Line for Windows* (included with *The ARRL Handbook* and *The ARRL Antenna Book*), and Ward Harriman's, AE6TY, *SimSmith* program (**www.ae6ty.com/Smith_Charts.html**).

Notes

[1]Smith, Philip, *Transmission Line Calculator*, Electronics, Vol. 12, No. 1, p. 29 – 31, Jan. 1939.

[2]Smith, Philip, *An Improved Transmission Line Calculator*, Electronics, Vol. 17, No. 1, p. 130, Jan. 1944.

For more on Philip Smith (1905 – 1987, licensed as 1ANB), see the IEEE oral history at **https://ethw.org/Oral-History:Philip_H._Smith**.

Bill Conwell, K2PO, got his Amateur Extra-class license as a teenager in Murray Hill, New Jersey. In 1976, he ordered Smith charts for a high school math project from Smith's company, and was surprised when Phil Smith, who turned out to live nearby, delivered them to his door. Bill went on get an electrical engineering degree from Georgia Tech (where he did brief stints in antenna-related work for RCA and Radio Free Europe), and a law degree from Emory University. He now resides in Portland, Oregon, where he works as a patent attorney for Digimarc Corporation, dealing with data hiding technologies. You can contact Bill at **bill@conwellpdx.com**.

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Product Review

FlexRadio Systems FLEX-6600M HF and 6-Meter SDR Transceiver and *SmartSDR* Software Version 3

Reviewed by Martin Ewing, AA6E
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The FLEX-6600M is a top-performing software-defined radio (SDR) transceiver covering the ham bands from 137 kHz to 54 MHz, handling the common voice, CW, and data modes, and transmitting at 100 W on 160 through 6 meters. The FLEX-6600M has many features in common with the FLEX-6400M, which was reviewed by Joel Hallas, W1ZR, in the February 2019 issue of *QST*.

This review will focus on the differences between the FLEX-6600M and the FLEX-6400M. If you're not familiar with the FLEX-6400M, please consult Joel Hallas's review to get a good orientation before diving into the FLEX-6600M's specifics here. Note that a very similar model, the FLEX-6600, is available at a lower cost without the front-panel controls. The FLEX-6600 requires you to supply a separate FlexRadio Maestro controller (reviewed in the November 2016 issue of *QST*) or a Windows PC, iPad, or iPhone running FlexRadio's *SmartSDR* (*SSDR*) software. In this review, when I write "FLEX-6600" or "FLEX-6400," it will apply to both the panel-less model and the "M" model, unless otherwise noted.

Compared with the FLEX-6400, the FLEX-6600's most notable features are the dual spectral capture units (SCUs) and the number of panadapters and simultaneous audio outputs — four instead of two. (FlexRadio uses the term "spectral capture unit" [SCU] to refer to the combination of a single antenna input, preselector and preamp, and an analog-to-digital converter.) Having dual SCUs permits you to receive from two different antennas at the same time. This allows diversity reception, where you can combine signals from antennas located away from each other or from antennas with different polarization or directivity. With diversity reception, you can reduce the effects of fading, as you can choose whichever channel has the stronger signal. This is not automatic, however. You would probably listen to one channel with your left ear and the other with your right — assuming you're using headphones. Your hearing readily focuses on the better channel.

Each FLEX-6600 SCU operates at double the sampling frequency (245.76 MHz) of the FLEX-6400's single unit. All told, the dual FLEX-6600 SCUs internally generate four times the data of the FLEX-6400.

Bottom Line

The FLEX-6600M offers top-tier performance and, with its built-in seventh-order band-pass filters, is easily capable of operating full duplex on two bands at a time. *SmartSDR* Version 3 offers the opportunity for two operators to share the radio with some limitations. The transceiver can be controlled locally or remotely from a Windows-based PC, iPad, or iPhone running the appropriate *SmartSDR* software, or from FlexRadio's Maestro control panel.

That implies substantially higher computing power inside the radio. One benefit is that you can use four independent panadapter displays and waterfalls at one time, where the FLEX-6400 provides only two. The maximum bandwidth of a single panadapter display is also doubled, to 14 MHz. With only two such panadapters, you can continuously monitor all the HF amateur bands.

Another benefit of the FLEX-6600's high sampling rate is higher frequency resolution. With maximum zoom at 10 MHz, I noted (by eye) that the frequency bin size was about 4 Hz. The same test on the FLEX-6400 showed a bin size of about 8 Hz. When you're trying to pick out a very weak unmodulated carrier, the FLEX-6600's panadapter might provide approximately 3 dB better sensitivity, which could be important for VHF and higher bands.

Figure 1 — MultiFlex operation with a Maestro (top) and FLEX-6600M transceiver connected to a single antenna. The Maestro receives 30 and 20 meters, while the FLEX-6600M receives 80 and 40 meters.

Single-Operator, Two-Radio (SO2R) Operation

If you are careful to minimize cross coupling of your antennas, you can operate the FLEX-6600 in full-duplex mode (FDX) — receiving on one antenna at the same time as you transmit on the other. This capability supports so-called SO2R contesting (single operator, two radios) in which a skilled operator can find the next contact with one SCU while completing a contact that was started on the other. (There are a number of online resources giving details of SO2R setups and operations.[1]) This way, avid contesters can use a single FLEX-6600 to replace the dual-transceiver installation they might have needed before. FDX is also important when you are using the dual-operator "MultiFlex" mode, described below.

Two-Operator, Single-Radio (2OSR) — MultiFlex

FlexRadio's operating software for the FLEX-6000 series is known as *SmartSDR* (*SSDR*). Some components of *SSDR* run in the radio itself, while other parts (including the user interface) run in various devices that can serve as a "control surface" — the collection of knobs and buttons that make up FlexRadio's operator interface. The control surface can be the front panel of an "M" model, or a PC, an iPad/iPhone, or a Maestro, as mentioned above. Version 3 of *SSDR* was recently introduced. Its major new addition is multiplexing two operators onto one radio, a mode called "MultiFlex."

MultiFlex supports two control surfaces at once — called 2OSR for two operators with a single radio (see Figure 1). The second control surface can be connected locally (in the same room) or remotely over the internet.

Each MultiFlex control surface can control one to three receiver panadapters (receiver slices). There is only one transmitter, however, and either attached controller can transmit on a first-come first-served basis. Both control points are "live" for transmitting, so you need to take care if one of the operators is not licensed.

It happens that the Maestro and the "M" model's front panel, which are very similar, are both limited to two panadapters, while the FLEX-6600 radio supports four. So the combination of a Maestro and a FLEX-6600M in MultiFlex mode neatly makes use of all four control slots. Of course, a single PC running *SSDR* for Windows can show all four on one screen, if you prefer.

[1]One good explanation of SO2R contest operation is: R. Farmer, W8FN, "Basics of SO2R Operation," a paper presented at Ham-Com 2014, available as **www.dfwcontest.com/uploads/8/1/1/0/8110093/so2r_v2.pdf**.

Figure 2 — A Maestro in SmartControl mode controls and monitors a remote FLEX-6600.

Operating with the MultiFlex capability can be useful in a number of situations. For example, a mentor and a new ham can collaborate to learn how to make contacts. You can also support two separate operating positions in your own station. It's great for ham radio demos, too. Contesters can simplify and economize on the hardware needed to support multiple operators. Two operators on separate bands (with good antenna isolation) can share a single FLEX-6600. Occasionally, they may want to transmit at the same time, and one of them will have to wait.

MultiFlex does a good job of making the radio seem like a computer server with two independent users, but under some circumstances, it is possible for one operator to change the configuration in a way that could upset the other operator. FlexRadio says that "some means of coordination may be helpful." It's probably best to have an off-air way to talk with your remote colleague. At least you need to know who's going to be transmitting on what band, using what antenna.

More Features

SSDR Version 3 adds support of a new "Smart Control" mode, in which a Maestro can control a remote FLEX-6000 series transceiver (see Figure 2). It should be particularly useful as a controller for a "headless" (non-M) radio that otherwise is controlled via a PC. The SmartControl is effectively an enhanced version of the older FlexControl tuning knob product.

The FLEX-6600 includes an automatic antenna tuning unit. (This was optional on the FLEX-6400M). It also offers dual-transverter output and external receiver inputs that help with more complex VHF+ situations (see Figure 3 for the rear-panel layout).

Lab Notes: FlexRadio Systems FLEX-6600M

Bob Allison, WB1GCM,
ARRL Laboratory Test Engineer

FlexRadio Systems FLEX-6600M can handle high signal levels at the antenna jack. Its lowest dynamic range, at 2 kHz spacing, at 14 MHz, is 104 dB (third-order IMD dynamic range). Blocking and reciprocal mixing dynamic ranges are even better.

On the other end of the equation, the FLEX-6600M offers a wide range of receiver gain settings, starting with 0 dB, which provides the receiver with just enough gain to match an average background noise level of −115 to −110 dBm. If your background noise is at this level, or higher, set the gain to **0 dB**. This is equivalent to adjusting the RF gain on a traditional receiver so that the background noise is just audible, providing a better signal-to-noise ratio and easier copy of received signals. On the higher frequency amateur bands, where background noise levels are much lower, the additional receiver gain of the FLEX-6600M will allow reception of weak signals. AM sensitivity is adequate, especially on the higher bands, where signal levels at 1 μV or less can be heard. The panadapter and waterfall display are very sensitive. A watchful eye will not miss weak signals.

Transmit quality is very important. The best receivers cannot remove transmitted distortion products, wide CW sidebands, or high transmitted phase and AM noise. Laboratory tests showed low transmit phase noise at 14 MHz, and somewhat higher phase noise at 50 MHz. Transmit IMD products are acceptably low at all RF output levels. In CW mode, the CW sidebands are very low, making the FLEX-6600M a good neighbor for those listening close to its transmitted frequency.

Signal latency is an important consideration with software-defined radios. Receiver processing delay time is the time it takes from when a signal arrives at the antenna jack to when the signal comes out of the speaker. The more signal manipulation and processing, the longer the delay (latency) is. As shown in Table 1, adjusting the filter edges to **SHARP** takes slightly longer to process than when the filters are set to **LOW LATENCY**, where filter edges have a more tapered response.

The preselector filters on the "contest bands" (160, 80, 40, 20, 15, and 10 meters) have been upgraded to seventh order (>50 dB rejection), compared with third-order filters on the FLEX-6400. This improves rejection of interference from other transmitters operating in a multi-transmitter environment. We do not routinely measure cross-band isolation at the ARRL Lab, but we did a few checks on the FLEX-6600M compared with the FLEX-6400.

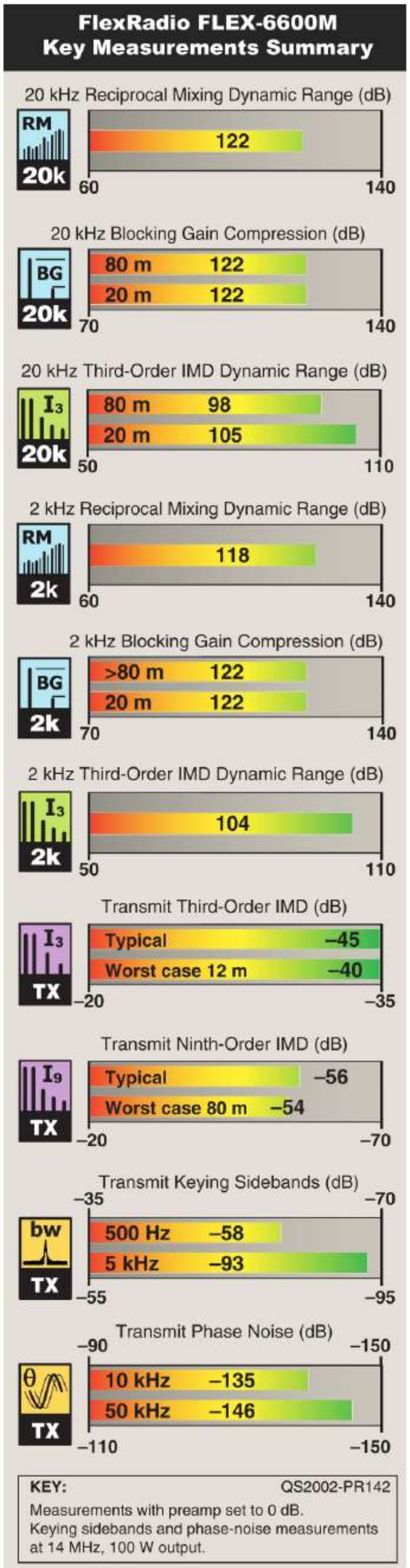

Table 1
FlexRadio Systems FLEX-6600M, serial number 0525-6601-4585, *SmartSDR* V3.1.8.145

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 0.03 – 54 MHz; transmit, 160 – 6 meter amateur bands.	Receive, 0.03 – 55 MHz. Transmit, 160 – 6 meter amateur bands including five 60-meter channels.‡
Power requirement: 13.8 V dc (±15%).	At 13.8 V dc: Transmit, 22 A (typical), 12 A (AM) at maximum RF power output; 5.8 A at minimum RF output. Receive, 2.8 A (maximum backlight), 2.8 A (minimum backlight). Power off, 114 mA.
Modes of operation: SSB, CW, AM, SAM, FM, Free-DV, RTTY, digital.	As specified.

Receiver	Receiver Dynamic Testing
SSB/CW sensitivity: Not specified.	Noise floor (MDS), 500 Hz bandwidth, AGCT=65.

Preamp	*0*	*+16*	*+32*
0.137 MHz	–115	–102	–94 dBm
0.475 MHz	–117	–113	–113 dBm
1.0 MHz	–117	–125	–121 dBm
3.5 MHz	–114	–126	–129 dBm
14 MHz	–114	–127	–136 dBm
50 MHz	–116	–134	–140 dBm

Receiver	Receiver Dynamic Testing
Noise figure: Not specified.	Preamp off/+16/+32: 14 MHz: 33/19/12 dB; 50 MHz, 31/13/7 dB.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1 kHz tone, 30% modulation, 6 kHz BW:

Preamp	*0*	*+16*	*+32*
1.0 MHz	15.5	4.67	6.60 µV
3.88 MHz	21.4	4.26	2.98 µV
29.0 MHz	18.8	2.66	1.00 µV
50.4 MHz	15.1	2.29	0.81 µV

Receiver	Receiver Dynamic Testing
FM sensitivity: Not specified.	For 12 dB SINAD, 3 kHz deviation, 15 kHz BW:

Preamp	*0*	*+16*	*+32*
29.0 MHz	6.23	0.93	0.31 µV
52.0 MHz	5.01	0.81	0.26 µV

Receiver	Receiver Dynamic Testing
Spectral sensitivity: Not specified.	Panadapter and waterfall display: 14 MHz, –144 dBm; 50 MHz, –154 dBm (maximum sensitivity).
ADC overload level: Not specified.	With preamp 0/+16/+32: +8/–7/–24 dBm
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz BW:*

	20 kHz offset Preamp 0/16/32	*5/2 kHz offset Preamp 0*
3.5 MHz	122/120/112 dB	122/122 dB
14 MHz	122/120/112 dB	122/122 dB
50 MHz	124/120/112 dB	124/124 dB

Receiver	Receiver Dynamic Testing
Reciprocal mixing dynamic range: 115 dB at 2 kHz offset.	14 MHz, 20/5/2 kHz offset: 122/120/118 dB

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth), AGCT = 65:

Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
3.5 MHz/0	20 kHz	–114 dBm	–16 dBm	98 dB
		–97 dBm	–6 dBm	
		–86 dBm	0 dBm	
14 MHz/0	20 kHz	–114 dBm	–9 dBm	105 dB
		–97 dBm	–3 dBm	
		–89 dBm	0 dBm	
14 MHz/+16	20 kHz	–127 dBm	–27 dBm	100 dB
		–97 dBm	–14 dBm	
14 MHz/+32	20 kHz	–140 dBm	–42 dBm	98 dB
		–97 dBm	–29 dBm	
14 MHz/0	5 kHz	–114 dBm	–9 dBm	105 dB
		–97 dBm	–3 dBm	
		–89 dBm	0 dBm	
14 MHz/0	2 kHz	–114 dBm	–10 dBm	104 dB
		–97 dBm	–6 dBm	
		–89 dBm	0 dBm	

Manufacturer's Specifications	Measured in the ARRL Lab

Band/Preamp	*Spacing*	*IMD Level*	*Measured Input Level*	*Measured IMD DR*
50 MHz/0	20 kHz	–116 dBm	–16 dBm	100 dB
		–97 dBm	–9 dBm	
		–76 dBm	0 dBm	
50 MHz/+32	20 kHz	–135 dBm	–35 dBm	100 dB
		–97 dBm	–27 dBm	

Manufacturer's Specifications	Measured in the ARRL Lab
Second-order intercept point: Not specified.	Preamp 0/+16/+32 dB: 14 MHz, +71/+71/+71 dBm; 21 MHz, +71/+71/+71 dBm; 50 MHz, +85/+81/+77 dBm
DSP noise reduction: Not specified.	12 dB.
FM adjacent channel rejection: Not specified.	Preamp +32 dB: 29 MHz, 81 dB; 52 MHz, 80 dB.
FM two-tone third-order IMD dynamic range: Not specified.	20 kHz offset, preamp +32 dB: 29 MHz, 81 dB; 52 MHz, 80 dB. 10 MHz offset, preamp +32 dB: 29 MHz, 127 dB; 52 MHz, 115 dB.
Squelch sensitivity: Not specified.	FM, preamp +32 dB: 29 MHz, 0.17 µV to 0.85 µV; 52 MHz, 0.14 µV to 0.71 µV.
S-meter sensitivity: Not specified.	S-9 signal, preamp 0/+16/+32 dB: 14 MHz, 50.1 µV (all preamp settings) 50 MHz, 50.1 µV (all preamp settings) Scaling: 6 dB per S-unit.
Notch filter depth: Not specified.	Tunable notch filter, normal, 45 dB; Auto-notch, >70 dB.
IF/audio response: Not specified.	Range at –6 dB points:† CW (500 Hz BW): 335 – 865 Hz; Equivalent Rectangular BW: 508 Hz; USB (2.4 kHz BW): 280 – 2718 Hz; LSB (2.4 kHz BW): 281 – 2718 Hz; AM (6 kHz BW): 28 – 4484 Hz.
Receive processing delay time: Not specified.	Auto, 170 ms; low latency, 56 ms; sharp filter, 167 ms.
Transmitter	**Transmitter Dynamic Testing**
Power output: 1 – 100 W (SSB, CW, FM), 1 – 25 W (AM).	SSB, CW, FM: As specified; AM: 1.8 – 30 MHz, 0.17– 23 W; 50.4 MHz, 0.1 – 17 W.
RF power output at minimum specified operating voltage: Not specified.	At 11.7 V dc: 1.8 MHz, 85 W; 14 MHz, 95 W; 50 MHz, 80 W.
Spurious-signal and harmonic suppression: >60 dB.	HF, >70 dB typical; 60 dB worst case band (1.8 MHz); 50 MHz, 75 dB. Complies with FCC emission standards.
Third-order intermodulation distortion (IMD) products: Not specified.	3rd/5th/7th/9th order, 100 W PEP: –45/–40/–50/–56 dB (HF typical) –40/–38/–48/–54 dB (worst case, 12 m) –47/–38/–45/–53 dB (50 MHz) At 50 W RF output: –36/–43/–51/–53 dB (14 MHz) –32/–40/–51/–57 dB (50 MHz)
CW keyer speed range: Not specified.	4.2 to 100 WPM, iambic mode A & B.
CW keying characteristics: Not specified.	See Figures 4 and 5.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S-9 signal, AGC fast, SSB, 200 ms; (sharp filter), 82 ms (low latency). CW (full break-in), 190 ms (sharp filter), 82 ms (low latency).
Receive-transmit turnaround time (TX delay): Not specified.	SSB and FM, 53 ms (sharp filter), 49 ms (low latency).
Transmit phase noise: Not specified.	See Figure 6.
Amplifier key line closure RF output: Selectable, 0 to 30 ms.	As specified. RF off to key line open, variable, 0 to 3 seconds.

Size (height, width, depth, incl. protrusions): 7.0 × 14.0 × 13.2 inches; weight, 11.9 lbs.
Second-order intercept points were determined using S-5 reference.

‡Adjustable low-level RF output for 137 and 475 kHz appears at the transverter jack: 137 kHz, –12 to +8 dBm and 475 kHz, –12 to +10 dBm.
*No signal blocking occurred up to the point of ADC overload.
†Default values; bandwidth is adjustable.

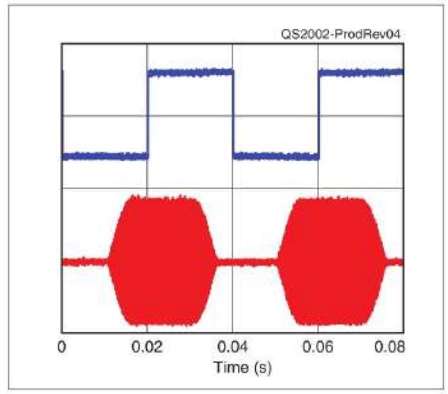

Figure 4 — A CW keying waveform for the FLEX-6600M, showing the first two dits in full-break-in (QSK) mode using external keying and the default 4-millisecond rise time setting. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 100 W output on the 14 MHz band.

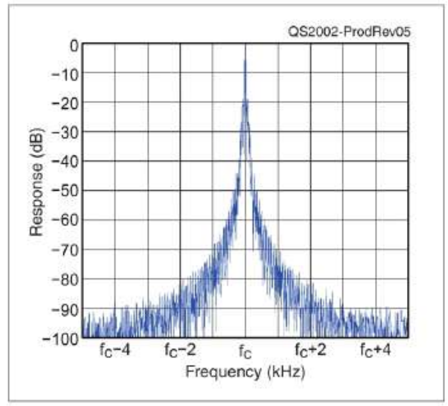

Figure 5 — The spectral display of the FLEX-6600M transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying and the default rise time setting. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 100 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dB.

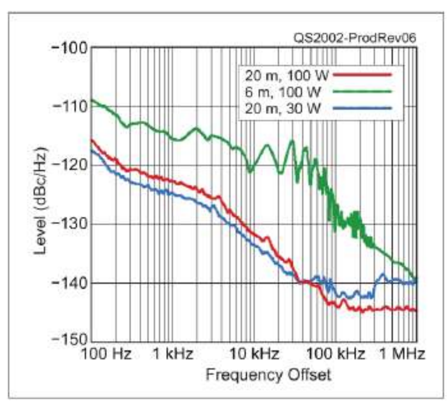

Figure 6 — The spectral display of the FLEX-6600M transmitter output during phase-noise testing. Power output is 100 W on the 14 MHz band (red trace), 30 W on the 14 MHz band (blue trace), and 100 W on the 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows phase noise 100 Hz to 1 MHz from the carrier. The reference level is –100 dBc/Hz, and the vertical scale is 10 dB per division.

When we listened to a signal generator on 7.15 MHz (S-5 signal level), we added a variable-strength "interference" signal at 14.2 MHz. With the FLEX-6400 (controlled by a Maestro), we noted that the radio tripped out at +17 dBm into its self-protect mode. (The FLEX-6000 series radios automatically disconnect the antenna if an excessive signal is put into the antenna jack. This will hopefully save your radio from harm, but you are not encouraged to test this limit.) With the FLEX-6600M, we saw no evidence of overload, even with +27 dBm "interference" input (½ W). This result shows that the FLEX-6600's improved preselector filter, at least for this particular test, was at least 10 dB better than the FLEX-6400's and most likely even better than that, but our normal safety guidelines prevent the use of very high signal levels.

Figure 3 — The FLEX-6600M rear panel.

In addition to operation on 160 through 6 meters, the FLEX-6600 supports operation on 630 meters (475 kHz) and 2200 meters (137 kHz). The receiver has usable sensitivity on those bands, and a low-level output, suitable for driving an external power amplifier chain, is available at the transverter jack. The radio could also be used with an external transverter, such as those from Monitor Sensors.

Discussion

Bench tests of the MultiFlex feature using the FLEX-6600M, a Maestro, and a Windows PC mostly worked as expected, but occasionally we ran into odd conditions where control appeared to end up with the "wrong" device. The situation was tricky to figure out, but a power reset will cure it. It would be handy if the control surfaces could show who is attached and how they are operating. As it is, all you get is an alert when the other station goes into transmit mode.

We also encountered some issues with MultiFlex and CW. Break-in CW can consist of a short transmit cycle for each code element. If operator 1 and operator 2 are trying to send CW at the same time, you will get confusing results as control flips between them between code elements or words. You might think that slowing down the break-in switching would help, but we were unable to find a foolproof way to handle this situation. Eventually, you and the other operator will try to transmit at nearly the same time. Even using non-break-in (MOX control), there are problems. If you hit your key when the other person is sending, you will often interfere with their transmission. We hope these issues will be addressed in a future software release.

You may want to disconnect a control surface if you're trying to switch MultiFlex setups. To turn off the FLEX-6600M's front panel and free up a slot for MultiFlex, you can go to the "radio" menu and select **SWITCH VERSION**, but on the Maestro you would go to **NETWORK** and select **WIFI SETTINGS**. A **DISCONNECT** button would have been more intuitive.

FlexRadio supplies a lot of good documentation for this radio and *SSDR* software — more than 400 pages weighing in at more than 4 pounds, single-sided. But, because the documentation often changes with software updates, it isn't practical to keep a fully updated hard copy. They are available as PDFs for downloading as needed. In addition, the FlexRadio community on FlexRadio's website can answer questions and provide assistance.

As we have come to expect from leading SDR products, software updates come along frequently. We worked with three separate releases during the course of this review. We ended up with *SmartSDR* version 3.1.8. If you have an older FlexRadio FLEX-6000 series radio, you may need to purchase a $200 license to upgrade to version 3 software. However, you can stay with an earlier version at no cost.

Final Thoughts

The FLEX-6600 and FLEX-6600M are the high-end transceivers of the current generation of FlexRadio FLEX-6000-series products. You can get higher performance (eight slices and panadapters) and support

MultiFlex and Remote Operation at the ARRL Lab

Bob Allison, WB1GCM,
ARRL Laboratory Test Engineer

FlexRadio's *SmartSDR* V3 software allows two operators to share one radio. We tried this feature while operating the FLEX-6600M remotely, using a Maestro at the ARRL Lab, and the FLEX-6600M connected to a router in the home station of ARRL RFI Engineer Paul Cianciolo, W1VLF, some 17 miles distant. It was a new experience for me to be able to share a radio with another operator without sitting next to them. Paul and I could listen on the same band or on separate ham bands simultaneously, and operation was seamless. For transmitting, FlexRadio gives its users a traffic-light system, with obvious indicators that the other is transmitting. Once one user finishes transmitting, the other may transmit. Whoever transmits first has priority and blocks the other user from transmitting. (Some limitations of this are explained in more detail in the main review.)

When the operator and control surface are separated from the transceiver, some latency is added by the signal path over a local area network or over the internet in the case of remote operation. To test latency, we used a keying generator to turn on the FLEX-6600M's CW transmitter, with the generator's keying action viewed on one trace of a dual-trace oscilloscope. The other trace viewed an analog receiver speaker output. When the key closed, I could measure the time it took from when the key was pressed on the Maestro in the Lab to when the signal was transmitted remotely from the FLEX-6600M at Paul's station and heard in the speaker (there is no significant latency in an analog receiver). This one-way path took 50 milliseconds and was confirmed with FLEX-6600M's internal latency metering, which stated a two-way latency of 100 milliseconds.

We found that latency increased if the router used at Paul's station was shared with other devices. For example, if he turned on another remote receiver connected to his home router, latency with the Maestro in the Lab controlling the FLEX-6600M at his station increased to about 300 milliseconds. (In addition, we note that some users have reported unusual latency problems using CW over remote connections with recent SSDR versions. See **community.flexradio.com**. It is not clear if our experience is related to this issue.)

We asked FlexRadio's Vice President of Engineering, Steve Hicks, N5AC, for his thoughts on latency, and here is his response:

> For remote operations, the two key things that affect latency are the degree of filtering in the radio itself and the latency observed in the network. The operator of a FlexRadio has tremendous control over the latency inside the radio. Each mode (CW, voice, and digital) has a control that can be set for lowest latency, highest degree of filtering, or a balance of these. The latency observed in the network can affect operations, but a number of strategies with the radio have been employed to minimize the effects of latency including using multiple different internet protocols and measuring which are faster, given your particular network connection. Also, to reduce latency when using SmartLink, the SmartLink server initially establishes connections to both the radio and the operator's device (Maestro, PC, etc.), but then brokers a final connection directly between the radio and the operator. By brokering the connection, the SmartLink server ensures that the network can find the quickest path between the operator and their radio without standing in the middle of the connection…Ultimately, all operators using their radios remotely will have some latency from the network which is unavoidable, but much of the time it is minimal and is not a hindrance to operations.

for the 2-meter band with the older FLEX-6700 that is still in production. But it's likely that most amateurs would be satisfied with the FLEX-6600 and its lower price point.

The MultiFlex dual-operator feature appeared to work well in our Lab tests described above and in the sidebar, "MultiFlex and Remote Operation at the ARRL Lab." Features such as MultiFlex and remote operation are hard to evaluate in the Lab, because we would need to explore all the edge cases of marginal internet service, long latency, along with various operating modes, band conditions, and so on. We verify that things work nicely on the bench, but the community will have to see how these features fare in real life.

SSDR version 2 gave us an easy-to-use remote capability. Version 3 now extends that to dual-operator access. These important extensions to the FLEX-6000 series validate one of the selling points of software-defined radio — that an SDR hardware investment can be continually improved through software development.

Manufacturer: FlexRadio Systems, 4616 W. Howard Ln., Suite 1-150, Austin, TX 78728; **www.flexradio.com**. Price: FLEX-6600M, $4,999; GPS disciplined 10 MHz oscillator, $699.

DX Engineering RX Share Audio Switch

Reviewed by Mark Wilson, K1RO
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There are times when two operators might want to listen to the same radio, or one operator might want to listen to two radios. The RX Share from DX Engineering offers a convenient and flexible way to share audio. It's a passive device requiring no power source (no internal amplifiers or signal processing). Audio quality and volume are controlled by the transceiver(s).

Cables connect to the rear panel (see Figure 7). The Radio 1 and Radio 2 inputs are silver ¼-inch stereo jacks. Headphones connect to either the black ¼-inch stereo jacks or the ⅛-inch stereo jacks. No cables are supplied with the unit. I had a couple of suitable shielded audio cables in my junkbox to connect to the headphone jacks of my transceivers.

RX Share is set up for a typical 8 Ω system, but can change the impedance to 600 Ω by swapping some internal jumpers. Each audio channel uses an isolation transformer to prevent ground-coupled crosstalk or RF pickup. The transformers are specified to handle up to 1 W of audio. There's also an internal ground jumper that can be used to connect the input common or the output common to the enclosure, or it can be removed. The manual suggests experimenting with this jumper if you experience RF pickup in the headphone audio.

Using the RX Share

For the **SHARED RADIO** mode, connect the transceiver to the **R1 INPUT** jack and headphones to **HEAPHONES OPERATOR 1** and **HEADPHONES OPERATOR 2**. It's not mentioned in the instructions, but I found that the transceiver has to be connected to the **R1** input, and not the **R2** input, for **SHARED RADIO** operation.

Set the center rocker switch to **SHARED RADIO** and the transceiver audio will be heard in both headsets. Some transceivers have two receivers with separate main and subband audio outputs. In that case, each operator can use their rocker switch (see Figure 8) to select main receiver audio in both ears, sub receiver audio in both ears, or main in one ear and sub in the other.

Figure 7 — The RX Share connections include two sets of ¼- and ⅛-inch stereo headphone jacks, and a ¼-inch stereo jack for connection to each receiver.

Because the volume for both operators is controlled by the transceiver, this device works best when both headsets have similar impedance and sensitivity, and both operators have similar hearing sensitivity. If there is a significant difference, the manual suggests moving the internal impedance jumpers to reduce the volume on one side or the other.

For the **SEPARATE RADIOS** mode, connect audio from a second transceiver to the **R2 INPUT** and switch the center rocker switch. Now, each operator can use their rocker switch to select Radio 1 audio in both ears, Radio 2 audio in both ears, or one radio in each ear (or a single operator can listen to these combinations for SO2R contesting).

Bottom Line

The DX Engineering RX Share offers a safe and convenient way for two operators to share the audio from a transceiver, or for one operator to listen to audio from two transceivers.

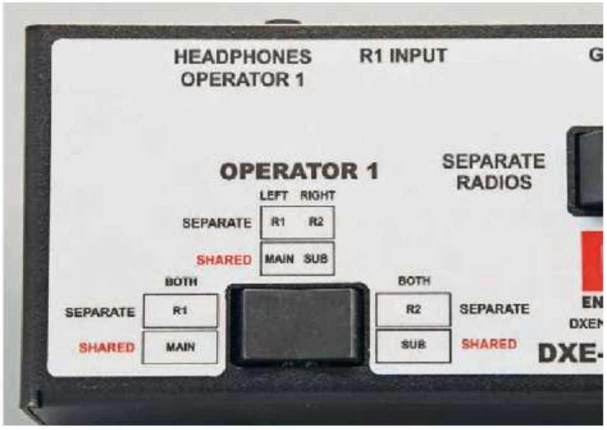


Figure 8 — Large rocker switches are used for selecting the various audio streams heard in the headphones.

The RX Share is well made. It weighs nearly 4 pounds, and with its large rubber feet, it stays put on the operating desk. The rocker switches operate smoothly, and after a few minutes, I was able to operate them by feel while looking at my radio or computer.

Manufacturer: DX Engineering, 1200 Southeast Ave., Tallmadge, OH 44278; **www.dxengineering.com**. Price: $189.99.

Workbench "Third Hand" Circuit Board Holders

Reviewed by Paul Danzer, N1II
n1ii@arrl.net

While assembling small projects on printed circuit (PC) boards, it can be helpful to have something to hold the board while you work. Oftentimes, you feel like you need a third hand. We checked Amazon and chose several PC board holders that looked useful, and also ordered a unique one from a ham radio kit supplier. Each design has advantages and disadvantages, and picking one depends largely on the features you prefer. The units shown were available as of mid-November 2019.

For this review, I used each unit to install components on a small board (3 × 5 inches). I also used my normal soldering tools — a 40 W pencil-tip soldering iron, a good light, and a magnifying device, unless there was one built into the board holder.

Helping Hand Magnifier

This small, inexpensive unit is a classic design offered by many companies. The one we ordered carried the model number MZ101B, but identical devices are available under various brand and model names. There are two versions — one with an integrated magnifying glass, as shown in Figure 9, and one without. The unit shown here has a 2½-inch lens with 4× magnification. All joints are friction fit, and the various clips and arms are secured in place by tightening thumb screws. Two alligator clips are mounted on the end of the horizontal bar to hold the PC board.

After inserting a component on the top side of the PC board, you usually have to take the board out of the clips to turn it around and solder the reverse side. Then you remount the board to repeat the process for the next component. The base is heavy enough to support small PC boards without tipping over. While

Figure 9 — The classic and inexpensive Helping Hand design is available with and without a magnifier.

Figure 10 — The LED Light Helping Hands Magnifier Station includes several soldering aids and two magnifying lenses. It uses the same two alligator clips to hold your work as the device shown in Figure 9.

the Helping Hand Magnifier is not the most convenient to use, it's the least expensive one tested.

Available from Amazon (search for "SE MZ101B" or "Helping Hand Magnifier"). Similar devices are available with other model names. Price: about $7.95.

LED Light Helping Hand Magnifier

The circuit board holder shown in Figure 10 is available under several brand names, and we ordered the YOCTOSUN version. This device uses a horizontal bar with thumbscrew-mounted alligator clips, very similar to the Helping Hands Magnifier described above. The 7.5 × 3.5 inch base has a soldering iron holder on the back and a small tray on the front to hold a wet sponge for cleaning the soldering iron tip as you work. A small plastic vise can slide over the horizontal bar to hold small assemblies (see Figure 11), and at the very front are three drawers to hold small parts.

Two magnifying lenses mount on a pivoting arm. The larger lens (approximately 3-inch diameter) is a

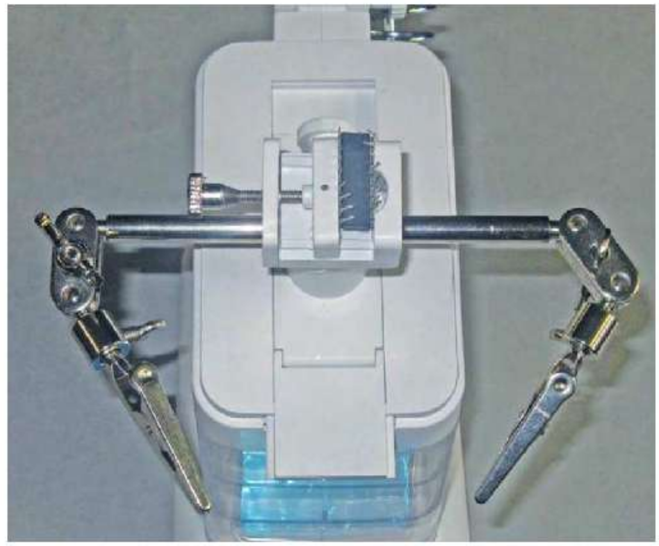


Figure 11 — A small vise, shown here holding an integrated circuit upside down to have its pins straightened, is included with the device shown in Figure 10.

3× magnifier, and has a 4.5× magnifying lens scribed inside. The smaller (¾-inch diameter) lens offers 25× magnification and can be used alone or in conjunction with the larger lens.

The large lens is surrounded with 10 LEDs, which I found to be bright enough to illuminate the work without excessive glare. The light can be powered from three AAA batteries or from a standard USB port (a matching USB cable is supplied). There may not be enough room to use your soldering iron with the magnifiers in place, but they easily pivot out of the way. A rectangular extension slides in and out to move the holding bar (and your work) backward and forward.

Available from Amazon (search for "YOCTOSUN Helping Hand Magnifier"). Similar devices are available with other model names. Price: about $16.99.

Helping Hands Third Hand Soldering Tool and Vise

Resembling a four-armed octopus with a magnifying head, the Helping Hands Third Hand by PSIVEN comes unassembled in a padded box weighing a hefty 4 pounds. A cloth bag and optical cleaning cloth for the 3¼-inch magnifying glass are included. Surrounding the 3× magnifier are 16 LEDs with two selectable levels of brightness, and the light is connected to a USB cord for power (power supply not included).

Assembly time is about 5 minutes, and it would have been easier if the screws connecting the arms to the base were longer. As shown in Figure 12, four flexible arms with alligator clips hold the circuit board. Two of the arms extend 14¼ inches from the base to the tip

Figure 12 — The PSIVEN Helping Hands Third Hand Soldering Tool and Vise has four alligator clips and a magnifying lens with an LED light source, giving a lot of meaning to the word "flexibility."

of the alligator clip, and two extend 10½ inches. When it's used on a 36-inch-high workbench, you can work standing up with the holding arms extended.

Small rubber covers fit over the alligator clip noses to prevent scratching. The base of each alligator clip plugs into a plastic assembly on the tip of a flexible arm, and the alligator clips can be rotated. Turning the notched wheel locks the clip in place.

When holding the PC board with all four arms, I found it a bit awkward to bend the arms to the same level. In addition, if you want to work on the other side of the board, you have to unclip the board, turn it, and reset the clips. I found that using two alligator clips was sufficient to hold small boards firmly in place. If you use two clips and don't tighten the wheels completely, you can rotate the PC board from the component side to the solder side without unclipping the board.

The magnifying lens worked well, and its flexible stalk made it easy to move out of the way if needed. I also found that using the LED light source without using the magnifier was convenient.

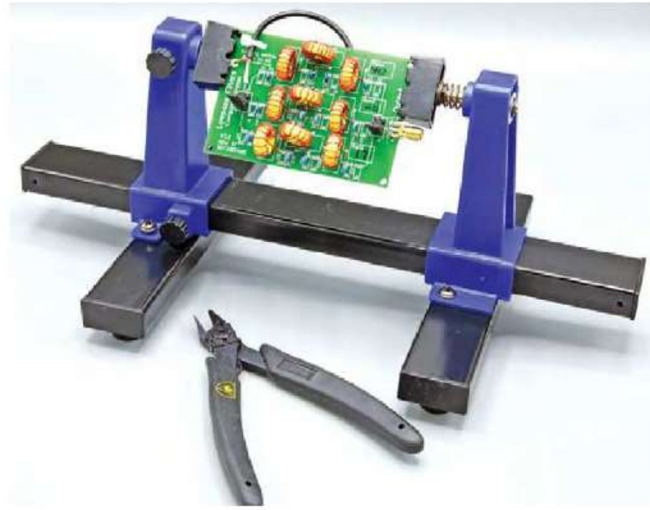


Figure 13 — The Aven Adjustable Circuit Board Holder resembles a lathe. The PC board is easily rotated.

Amazon carries several similar-looking devices with or without the magnifier and light. To find the one shown here, search for "PSIVEN Helping Hands." Price: $39.95.

Aven Adjustable Circuit Board Holder

The unit shown in Figure 13 resembles a small lathe with end posts to grab the edges of a PC board. It can be used with a board as long as 7¾ inches and as short as perhaps ¾ inch. The arms slide along the base and can be locked in place by thumbscrews with knurled knobs. Some simple assembly is required.

Each arm has a metal clamp that accepts the edge of a circuit board. The clamp on one arm is spring loaded, and the other is fixed. To use the device, set the arm with the fixed clamp at the desired position and lock it down. Place one edge of your circuit board in the fixed clamp and slide the arm with the spring-loaded clamp up to the opposite edge, compressing the spring enough to provide tension to hold the board in place. Lock that arm down and you're ready to work. Note that the clamp shafts also have thumbscrews that can be used to prevent the board from rotating if desired.

Once in place, the board is held solidly, but it does not take much to knock the board out of its mount. The clamps that hold the board rotate 360 degrees. If your PC board is less than 5½ inches wide and centered in the clamps, you can rotate it completely to work on the component side or solder side at any angle. If it's more than 5½ inches, you can still rotate it back and forth to get at both sides.

Figure 14 — The QuadHands Flip Circuit Board Holder resembles the Aven unit, but is much more rugged and holds a larger PC board.

Search for "Aven 17010" on Amazon. Price: about $12.95. Several similar-looking devices are also shown.

QuadHands Flip Circuit Board Holder

The QuadHands circuit board holder shown in Figure 14 is exceptionally rugged. Its hefty (2½-pound) base, with nonslip feet, holds two large end pieces with grooves to secure the PC board. It accommodates boards as long as 12 inches and as small as a fraction of an inch.

To use this device, loosen the wing nuts at the bottom of the end pieces and then move them so that the space between them is approximately ½ to ¾ inch smaller than the PC board. Then press the spring-mounted holder to compress the spring and insert the PC board. The spring tension is sufficient to hold the board firmly in place. The height of the end pieces allows rotation of a board as wide as 10 inches. Once the board is in place, it rotates easily to expose the opposite side or position it at any angle by turning the two end knobs simultaneously.

When tightening the wing nuts, the matching screw is kept from rotating by a rubber or plastic nut beneath the base plate. You may have to either tilt the end piece up slightly or pull on the wing nut to keep the screw from rotating. This holder is great for larger boards and won't move around on your workbench.

Search for "QuadHands Flip Circuit Board" on Amazon. Price: about $47.95.

Figure 15 — A Brass Set from QRPme is quick to set up and is designed for small QRP projects. The nylon screw lengths give you room for protruding parts when the assembly is turned over.

A Brass Set from QRPme

Finally, we tried A Brass Set from Rex Harper, W1REX, at QRPme. This company supplies a wide range of kits, tools, and accessories of interest to hams. As you can see in Figure 15, this circuit board holder consists of four brass cubes, each measuring approximately ½ inch per side. Each cube is milled out to have a triangular slot through one corner, and it is threaded for a nylon screw. When the corner of a PC board is inserted in the slot, the nylon screw clamps the board in place.

With the brass cubes oriented as shown in the photos, with the component side down, the board is about an inch above the workbench surface. This gives clearance to protruding components. Turn it over, and the solder side is approximately ¼ inch from the workbench.

Of all the devices reviewed here, this one makes it most convenient to turn a small PC board over and position it at any angle as you work. The one issue I noted is that the nylon screws are slippery, so you may want to place it on a nonslip mat to keep the board with attached cubes from sliding as you work.

Available from QRPme, **www.QRPme.com**. Price: $17 for the set of four cubes.

Joel R. Hallas, W1ZR, w1zr@arrl.org

A Moxon Rectangle Compared to a Yagi

Q Tom, KN4KFH, asks: I live in a townhouse subject to antenna restrictions. I currently have a multiband HF trap dipole in the attic that works fairly well. I'd like to try working 6 meters, and what I've read about three-element Yagi and Moxon antennas indicates that the Moxon would take up less space and its forward gain and front-to-back ratio (F/B) are higher than those of the Yagi. If this is true, why would anyone consider a Yagi over a Moxon? The antenna in my attic would be about 15 feet off the ground and would need to transmit through wood and asphalt shingles. Do you think it will work out for me?

A The Moxon is actually a two-element Yagi with its driven element and reflector bent inward to form a rectangle, with a gap between the element ends (see Figure 1). A Moxon is an excellent, easy-to-reproduce antenna with a smaller footprint than a full-size two-element Yagi and, if built to proper design, provides a direct match to 50 Ω transmission lines. While the gains and size vary with different designs, my Moxon and Yagi models yield quite different results. A typical three-element Yagi will have about 12 – 14 dBi forward gain, depending on boom length, with longer boom designs typically having more gain. This compares to about 11 – 12 dBi for a Moxon. These numbers should be compared to about 7.6 dBi for a half-wave dipole, all at 15 feet above ground. The azimuth patterns for both of my *EZNEC* (**www.eznec.com**) models are shown in Figures 2 and 3.

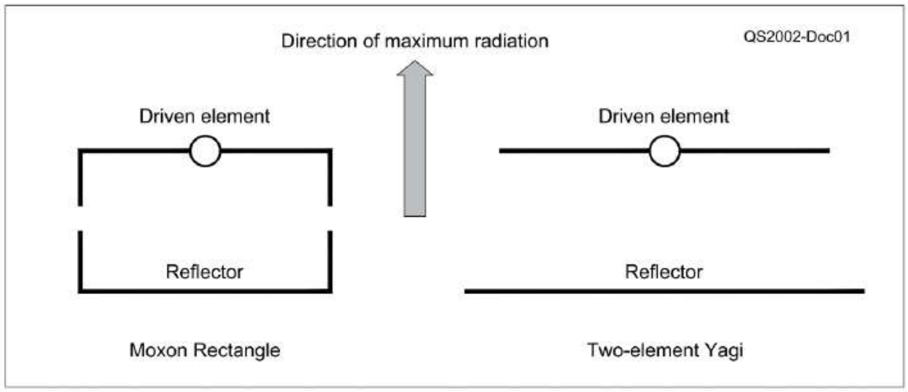


Figure 1 — Illustration of the configurations of a Moxon Rectangle antenna and a two-element reflector Yagi. While a two-element Yagi can also be configured with a director element, the Moxon design only uses a reflector.

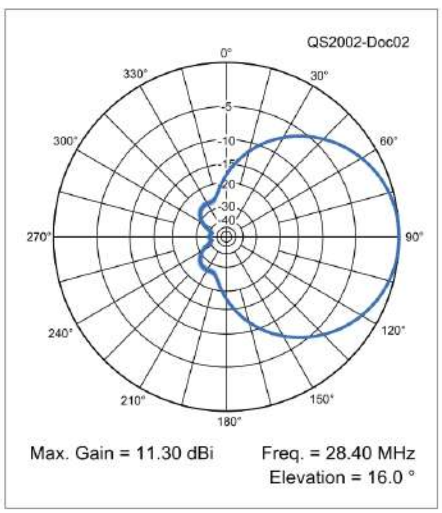


Figure 2 — Typical azimuth pattern of a Moxon beam. Note the deep rearward null.

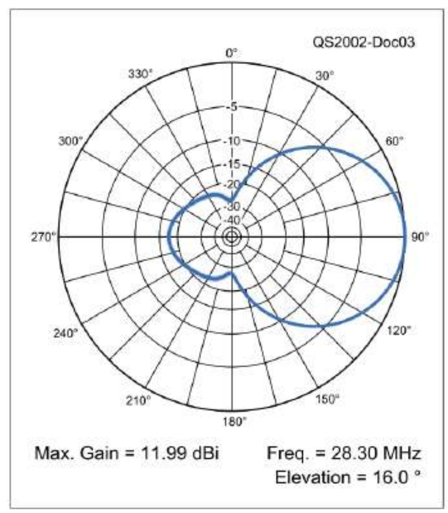


Figure 3 — Typical azimuth pattern of a three-element reflector Yagi. A two-element Yagi will have a larger rearward lobe and less forward gain, with a somewhat wider forward lobe.

The gain advantage of the three-element Yagi is not surprising to me because the Moxon is basically a two-element Yagi. The major advantages of the Moxon are that it is easy to reproduce, is typically made with mostly wire elements, is easy to tune with a tape measure, avoids the hazard of pointy element ends in an attic, and takes up less space. The footprints are about 18 square feet for the Moxon and 35 square feet for a typical three-element Yagi. Therefore, the Moxon gives you much more room for other antennas in your attic. You will want to have your beam on a rotator to take full advantage of its directional properties, but without wind load, a small TV antenna rotator will provide plenty of capacity.

The Moxon does have superb F/B, up to about 10 dB deeper than most two-element Yagis I've seen, but I don't see that as a big deal on VHF. With VHF there are more times that it's good just to know that someone is out there (even on the backside of your beam) than times you need to null out an interfering station. For more information, read our review of a lightweight 6-meter stressed-wire Moxon in the March 2004 issue of *QST*, or learn how to build your own from, "A 6-Meter Moxon Antenna," in the April 2004 issue of *QST*.

Many people have had good luck with attic Yagis and Moxons, especially with wood and shingle roofs — not so much with metal roofs, or if there is a lot of ductwork nearby. I think you will be happy you tried it with either antenna. Your attic system, even at 15 feet, should work well for sporadic E-layer propagation.

I would vote for the Moxon. I am thinking that you will be using it horizontally polarized for SSB and CW, and suggest that you also add a 2-meter Moxon or Yagi if you have a radio that operates on 2-meter SSB and CW — you will have lots of fun in the VHF contests!

Q Ken, N2DF, asks: I use a G5RV antenna for HF operation. It is fed with open-wire line that terminates at a window where it is attached to a balun, then continues via coax for about 30 feet to an antenna tuner. Are there any safety considerations in running open-wire line through the shack to the tuner? Can that open-wire line be laid directly on the floor as I would with coax or should it be mounted on some kind of insulated standoffs? Could it flash over and cause a fire?

A A G5RV dipole design has a transition from window or open-wire line to coax at a defined length, typically around 32 feet from the antenna. This window-line length operates as matching section, designed to provide a reasonable match to 50 Ω on multiple amateur bands. Thus, this window-line length is critical to make the antenna work as intended as a G5RV. A common-mode choke or 1:1 balun at the junction of the window line to coax is recommended to avoid common-mode current following the coax transmission line into the shack.

Running open-wire or window line all the way to the antenna tuner can make for a more efficient antenna, and will add 30-meter operation, but it is no longer a G5RV, rather a kind of short center-fed Zepp. I used that exact antenna for some years for all bands from 80 through 6 meters and was quite happy with it, but it does require a wide-range tuner that can interface balanced lines.

Window line does need to be kept away from lossy material or it will have unneeded loss, but it only needs to be about 2 to 3 inches away. I used the screw-in standoffs designed for TV 300 Ω twinlead, and put one side of the window line where the TV line was supposed to be. Be sure that bare open-wire line or window-line connections can't be touched by a person or pet.

If you have surfaces that you don't want to make holes in, devise some kind of standoff (just watch out for trip hazards). Walls are better than floors in this regard. I can't imagine window line flashing over at amateur power levels, although I'm sure I'll hear about any such cases.

♦ QST *Contributing Editor Kai Siwiak, KE4PT, offered additional information to add to my answer to Howard, KC3D, in the December 2019 column. Howard had asked if it is possible for lightning to get into his rig through a single ground wire. Kai's answer is maybe!*

Kai notes that a conductive path is not the only way that lightning can cause havoc with your amateur radio station. There is also a radiated path, resulting from what is sometimes called lightning-induced electromagnetic pulse (LEMP).

The lightning bolt conducts a transient current that gives rise to a magnetic field surrounding the lightning bolt. That magnetic field can then couple to a loop of wire in the station and generate potentially damaging voltages.

There would also be a corresponding radial electric field emanating from the lightning bolt that can couple current into nearby lengths of wire, including ground wires.

Kai notes that he lost the audio section of an HF transceiver because it was connected to nothing other than a bundled-up audio cable going to an external speaker. The lightning bolt struck a grounded J *pole antenna mast just a few yards away from the shack.*

Do you have a question? Ask the Doctor! Send your questions to "The Doctor," ARRL, 225 Main St., Newington, CT 06111, or email your question to: **doctor@arrl.org**.

Also listen to the *ARRL The Doctor is In* podcast, sponsored by DX Engineering, on iTunes, Blubrry, Stitcher, or on the ARRL website at **www.arrl.org/doctor**.

Strays

QST Congratulates…

John Rekus, WA3KBN, on being recognized by *Marquis Who's Who of Top Engineers* for his contributions to the field of safety engineering. John was licensed in 1967 and is an ARRL Life Member. He is the author of *The Complete Confined Spaces Handbook*, a 400-page illustrated textbook published by the National Safety Council.

Close Up

MFJ-1780 Box Fan Loop Antenna

Our May 2019 Product Review of this antenna didn't include a peek inside, so here it is.

A — Carrying handle

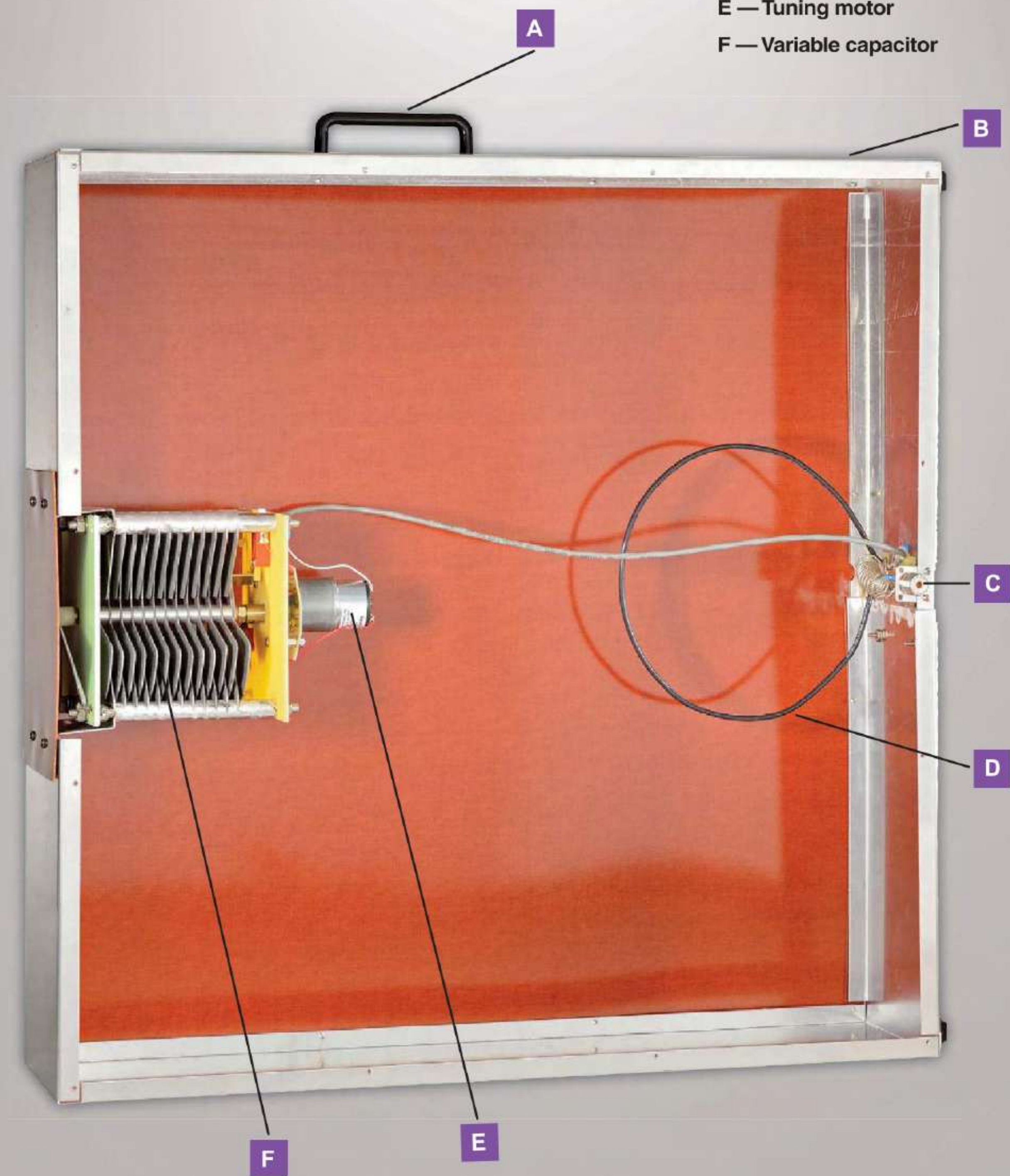
B — Primary loop

C — Antenna port

D — Coupling loop

E — Tuning motor

F — Variable capacitor



Hints & Hacks

Connecting Keys to Any Rig, Beating Dummy Load Interference, and More

Using Various Keys with Different Rigs

In the April 2018 "Hints & Hacks" column, I described an easy way to use short adapter cables to reverse the "dot" and "dash" keyer paddle orientation without rewiring the paddles. Since then, I have discovered other methods that are easier to implement and provide a more flexible way to use your paddles with a variety of rigs and electronic keyers.

The easiest method is to attach two or more cables to your paddle, with different connector plugs, selected to mate with various rigs (see Figure 1). Each can be wired with the left-right orientation to match the keying circuit. The disadvantage is having several cables connected, and the likelihood of tangles and an untidy appearance.

Another way to accommodate various paddles and keyers/rigs is to attach a stereo cable from each contact of the paddle (dot, dash, and ground), each terminated in an RCA-type phono plug. I used RCA-to-RCA two-conductor audio cables because I had some in my junk box. Then all that's left to do is to carefully strip the cable at the cut end and connect the ground and two wires to the terminals on the key.

◀ **Figure 1** — The easiest way to use your key with a variety of rigs is to attach cables to your paddle selected to mate with various rigs, then wire them with the left-right orientation to match the keying circuit. [Ron Pollack, K2RP, photo]

▼ **Figure 2** — Using inexpensive audio adapters is another way to connect a key to a different rig. [Ron Pollack, K2RP, photo]

Audio adapters are available inexpensively online in various configurations. Insert the appropriate adapter plug for each of your keyers and transmitters. Remember to select a stereo adapter on the rig end and mono on the input end (see Figure 2). Then, just plug the RCA plugs into the adapter in the rig for either "dot left" or "dot right" operation. Of course, instead of RCA plugs, other input plugs can be used with appropriate adapters, such as ¼- or ⅛-inch if you have those on hand. It's a quick, flexible way of utilizing various keys with various rigs. — *73, Ron Pollack, K2RP,* **k2rp@arrl.net**

Fixing Dummy Load RF

I built a dummy load similar to the "Build an Inexpensive 150 W Dummy Load with Wattmeter" project by Jack Purdum, W8TEE, and Al Peter, AC8GY, featured in the November 2018 issue of *QST* (although mine did not have the wattmeter). I wanted to share something I encountered.

The first time I tried to use my dummy load, multiple devices in my home

Figure 3 — A jumper wire soldered from the can to the lid got rid of the dummy load's RF. [Al Forbes, KJ4YEV, photo]

had RF interference that did not occur with an antenna. I discovered that the dummy load was radiating RF because the can was not shielding the resistors. There is a grey coating on the inside of the lid and inside the can (I assume it is there to prevent oxidation). Because of this coating, there was no continuity between the grounded lid and the can.

I resolved the issue by soldering a jumper wire from the lid to the can (see Figure 3). Fortunately, the can was made of a material that takes solder easily and this fixed my RF problem. — *73, Al Forbes, KJ4YEV,* **alphaal3@bellsouth.net**

Amplifier Tube Socket Repair

I noticed that as I was tuning up my Drake L-4B HF amplifier to chase a DX station, it was only putting out about half its normal power. I soon discovered that one of the two 3-500Z tubes was not "lit" (the filament was not on). After taking the amp apart, I found that the dark tube had a filament pin where the solder had slightly reflowed downward out of the pin — an indicator of excess heat at that pin, probably caused by a poor connection. I thought the tubes were just showing their age, so I replaced them with a pair of new units from RF Parts (**www.rfparts.com**).

The same half-power fault occurred again, and when I checked I found the tube in the same position as before that would not light. I disassembled the amp and found the same filament pin solder reflow issue had manifested itself on the new tube (see Figure 4).

I looked for solutions online and found a forum where this exact problem was being discussed. One contributor wrote that the spring clips that compress the small split-style tube holding connectors into which the tube pins are inserted can lose their "springiness" over time and that it was a simple affair to either replace the clip or attempt to squeeze it back into proper shape. This wouldn't be a great option for me, because it had already deformed previously and would be prone to doing so again. Fortunately, I had a few spare 3-500Z sockets and I found that it was very easy to remove one of the good spring clips.

Figure 5 — The loose clip (left) compared to the replacement clip (right). [Dino Papas, KLØS, photo]

I went back into the amp, replacing the spring clip in less than a minute. The difference between the old and new clip was substantial (see Figure 5).

I then "reflowed" the solder in the offending filament pin by turning the tube upside down, carefully applying heat to the pin and adding a small amount of silver solder to the mix. After letting the pin cool, I checked the continuity between the two filament pins and it was still okay. I made the same repair to the original tube, since it's now part of the backup pair. With the tube reinserted into the socket, the difference was apparent (see Figure 6).

If you have an amplifier, you may want to check the tube socket pins. Be careful, however, because the voltages inside your amp are very dangerous and can prove lethal. Always make sure the power is disconnected, the high voltage is bled off properly, and that you never defeat any voltage interlocks. — *73, Dino Papas, KLØS,* **kl0s@cox.net**

Figure 4 — The loose tube socket pin (compare the clip closure to the others). [Dino Papas, KLØS, photo]

Figure 6 — The new spring clip compresses the pin holder tighter than before. [Dino Papas, KLØS, photo]

"Hints and Hacks" items have not been tested by *QST* or ARRL unless otherwise stated. Although we can't guarantee that a given hint will work for your situation, we make every effort to screen out harmful information. Send technical questions directly to the hint's author.

QST invites you to share your hints with fellow hams. Send them to "Attn: Hints and Hacks" at ARRL Headquarters, 225 Main St., Newington, CT 06111, or via email to **hh@arrl.org**. Please include your name, call sign, complete mailing address, daytime telephone number, and email address on all correspondence. Whether you are praising or criticizing an item, please send the author(s) a copy of your comments.

Steve Ford, WB8IMY, wb8imy@arrl.org

Alexa & Amateur Radio

In response to my November 2019 column about the future of voice recognition, I received an interesting email from Jeremy Turner, NØAW. I've obviously heard of the Amazon virtual assistant, Alexa, and how it functions through voice commands, but I didn't know that users can create specialized Alexa routines known as "skills" and make them publicly available. Jeremy explains to the right.

If you are an Alexa owner, you can download Jeremy's free skills onto your device by searching for "Current Ionospheric Conditions" or "Parks on the Air" in the Alexa Skills department on Amazon.

Ham Skills for Alexa

I've been dabbling with Alexa skills for about 2 years now. I published my first skill as a basic way to read back ionospheric conditions for the HF bands. The second one is for Parks on the Air (POTA), and it allows users to ask Alexa for a list of stations currently spotted. Alexa reads back the information you would expect to see on your standard DX cluster-spotting list, but in a natural language.

My skill translates letters into the phonetic alphabet, includes a park name along with the identifier, and more. I'm working on additional functionality including the list of stations who scheduled themselves to be in a park, or to find more information about a park, including previous activations, ways to get there (if the park is only accessible by hiking, boat, or driving), and more.

I think of it as a new style of user interface. The key is that if your back-end data systems are API driven to add, modify, query, and delete, then you can put anything on the front-end with your users. That can be a website, a mobile app, or something like Alexa.

Your Alexa device communicates with the Alexa skills web service that turns speech into text and vice versa. You configure certain keywords which trigger the service to invoke an AWS Lambda function, which in my case is a little bit of *Python* code. That code generates a JavaScript Object Notation (JSON) response back to the Alexa skills web service with what I instruct Alexa to read back. I can even specify different inflections to tell her to slow down, speed up, and more.

It's very easy to get started with the AWS CodeStar service. This gives you a code repository and pipeline. When you commit your code, the pipeline deploys the new version of the Lambda function, and it's very slick. There are also Alexa blueprints, which make basic actions simple. They are available at **https://blueprints.amazon.com**.
— *Jeremy Turner, NØAW*

NØAW's Parks on the Air skill can be downloaded for free on Amazon for use on your Alexa device.

The Evolution of Power

A look at developments and innovations in power that make it easier than ever to power radios, cars, and even entire homes when the grid is down during an emergency.

Bob Bruninga, WB4APR

It's a new world of power. Universal high-voltage dc (HVDC) power systems have revolutionized our energy systems and are here to stay. A portable generator, long gas lines, whole-house-generators, incandescent bulbs and 60 Hz transformers are obsolete. Just 12 solar panels can fully charge any electric vehicle, and additional panels can provide the average power you need on a daily basis. While the grid is up, the total amortized solar panel investment in being grid-tied brings you power at less than half the cost of the utility.

Over the last few decades, the evolution of four disruptive technologies have led the revolution in power: power supplies, solar arrays, hybrid car generators, and long-range batteries, as covered in the ARRL book *Energy Choices*.

Power Supplies

The most obvious change in energy systems is evident in the progressive shrinking of power supplies, as shown in Figure 1. The modern light weight of power supplies make portable and emergency operations much more flexible. Their practicality arises from their universal input voltage range that can operate on any voltage from 100 to 240 V at 50 and 60 Hz and even dc (see Figure 1).

Figure 1 — Modern supplies use dc/dc switching to convert universal power input voltages both ac and dc into any required output voltage in only 10% of the space and weight of old 60 Hz supplies.

The hidden gem in this evolution is the fact that most of these supplies can operate on dc as well as ac. This is because they first rectify the ac mains to dc and then use that to drive a dc-to-dc switching converter to any desired fixed output voltage independent of the input voltage. As a result, these universal supplies can also operate on input dc voltages from 100 V to 330 V dc (the peak dc voltage of rectified 240 V ac). And of 15 tested in my lab, all would still operate at 70 V dc input or lower.

Solar Arrays

Because of affordability, home solar technology is another disruptive HVDC energy system that has grown popular over the last decade (see Figure 2). By 2013, grid-tie (GT) systems were able to produce amortized home power at half the cost of the utility by eliminating the battery costs, replacements, and maintenance. Without batteries, the typical GT string array operates in series at voltages of 200 to over 500 V dc. With the 30 V dc panels in series, modest wire gauges can be used to deliver several kilowatts, but at modest currents under 10 A. This is then converted by a grid-tie inverter to produce economical electricity below retail rates. The only disadvantage is that a GT inverter only pushes power back to the grid when the grid is up and shuts down when the grid goes down.

Figure 2 — WB4APR's solar panels now produce power at half the cost of the utility.

Hybrid-Car Generators

Introduced in the US in 2002 with the Prius, hybrid car systems are the third disruptive HVDC technology that's become popular, using a mix of gasoline engines and at least a 50 kW generator/motor operating at 200 to 240 V dc. Though for continuous power, the internal HVDC fusing is at about 120 A, which limits available electrical power to about 24 kW maximum. Theoretically a hybrid car generator is capable of powering a whole neighborhood during a power outage — if the manufacturers gave us access to it, but these vehicle-to-home power systems are currently only offered in Japan by Toyota and Nissan.

Although the battery in a gas hybrid can develop peak powers during acceleration and braking, typical battery capacity is about 1 kWh. However, plug-in hybrids can run on battery alone for tens of miles and have ten times bigger battery capacity. For example, in William Treharne's, N8HKU, article in the June 2018 issue of *QST*, he details how he ran a 6-hour radio event from his plug-in Ford Fusion Energy without the engine starting, and still had 62% of battery capacity remaining. These plug-in hybrids revolutionize the ham's approach to emergency power.

Long-Range Battery Electric Vehicles

The fourth technology arose from the hybrids as the cost of Lithium batteries declined, and it was practical to build a completely electric vehicle (EV). Now, EVs have an HVDC battery capacity from 32 kWh to over 100 kWh with driving ranges over 300 miles. This is enough battery energy to power the average home at normal loads for 4 days, or up to 2 weeks under emergency conditions. Additionally, because the EV's voltage levels are similar to those of home solar series string arrays, charging during grid-down conditions could be like having reliable emergency transportation and home energy indefinitely. In the meantime, any simple 12 V inverter (see Figure 3) connected to any hybrid or EV can provide up to 1 kW of continuous grid-down power for days.

Figure 3 — Hybrids typically have 50 kW or more of HVDC generation capability. My Prius hack has outlets on the back for the 220 V dc hybrid power and for about 1,000 W from a 12 V inverter in the trunk.

Universal Input High-Power Inverters

The common thread here is the ubiquity of universal HVDC power systems that allow us to power almost all modern electronics devices, radios, cell phones, TV, computers, etc., but the bad news is that almost everything other than your ham radio and cell phone that you really need in a long-term grid-out scenario all require 60 Hz power at 120 V ac to run. Consider your refrigerator, freezer, furnace, well pump, and most other home appliances. And even though most hams have an inexpensive 12 V dc inverter, there are only a few off-the-shelf 120 V ac inverters at significant power levels that can run on universal dc inputs.

The holy grail of emergency backup power, then, is finding a way to take the HVDC from a solar system, or hybrid, or EV battery and converting it directly to 120 V ac when the grid is down. Surplus high-power uninterruptible power supplies (UPS) in data centers take 200 to 380 V dc input and can produce up to 6 kW of 120 or 240 V ac output (see Figure 4), but these are rare, and therefore expensive.

Figure 4 — Some rare data center UPS supplies take 192 V dc input to produce up to 6 kW emergency power, which is ideal when connected to the 200 V battery in a Prius, for example. [Doug Gaede, photo]

Hacking a 12 V Inverter for 170 V DC Input

For the experienced hacker, however, it should be possible to hack into an inexpensive 12 V inverter and feed it from a 170 V dc input source. This is because all modern inverters switch 12 V and dc/dc to 170 V dc internally and use another dc switching circuit of high-power MOSFETs to pulse width modulate the 170 V dc into a smooth 60 Hz, 120 V ac sine wave. If you can tap into a 170 V dc point on your solar array, or use a 200 V input from a Prius or other similar-voltage hybrid, this is an inexpensive way to get 120 V ac power directly from the HVDC system. The 120 V input still has to remain connected to a 12 V source so that the inverter operates normally, but the bulk of the current being fed to the output would be from the 170 V dc external input.

Solar Secure Power

Fortunately, the SMA Sunny Boy brand of GT inverters (with a secure power outlet) meets the demand for emergency power from grid-tie solar systems (see Figure 5). When the grid goes down and the GT inverter stops producing power, a switch allows the power to be directed "off grid" to a single 15 A, 120 V outlet. This is also a place where you can plug in any 120 V electric vehicle car charger for continuous transportation in grid-down events. This power is available as long as the sun is falling on the array. Typically for a 3 kW system, even under overcast skies when a solar array produces maybe 10% rated power, the outlet can still provide 300 W of ac power.

Power at Night

While the GT inverter with secure power can provide plenty of kilowatts during the day, when the sun goes down, this same GT inverter can be fed with HVDC from any nearby hybrid or EV at 200 to over 500 V. With the input at these higher voltages, the wire out to the car can be any common #14 or even #16 wire extension cord, because it only takes 5 A at 300 V to produce the full 1,500 W for the secure power outlet at 15 A. (Note: until recently, you could not do any of this with microinverters.)

Heating and Cooling

A final shift is occurring in high-efficiency home heating and cooling with mini split heat pumps. These low-cost systems can be installed in any home without ductwork and provide ac cooling and heating at half the price of oil or propane while keeping the original system for those coldest nights. Further, to get high efficiencies, some of these systems are going with

Figure 5 — SMA grid-tie inverters have an option for a grid-down secure power outlet that can provide up to 15 A at 120 V for power.

variable speed fans and compressors, and this means they operate internally on rectified HVDC. With grid-down, one can still power these systems directly from 330 V dc from a solar array, hybrid, or EV.

Conclusion

Over the last few decades, the evolution of several disruptive developments has changed the power systems dramatically, but are still largely ignored by the average American consumer who just continues to buy more of the status quo. Few people investigate or understand the lower cost, independence, lower toxins, and cleaner air of these technologies that are now readily available and will definitely save money in the long run. Consider these possibilities the next time you need a new car, your roof needs repair, your AC or furnace needs work, or when you pay your next heating bill.

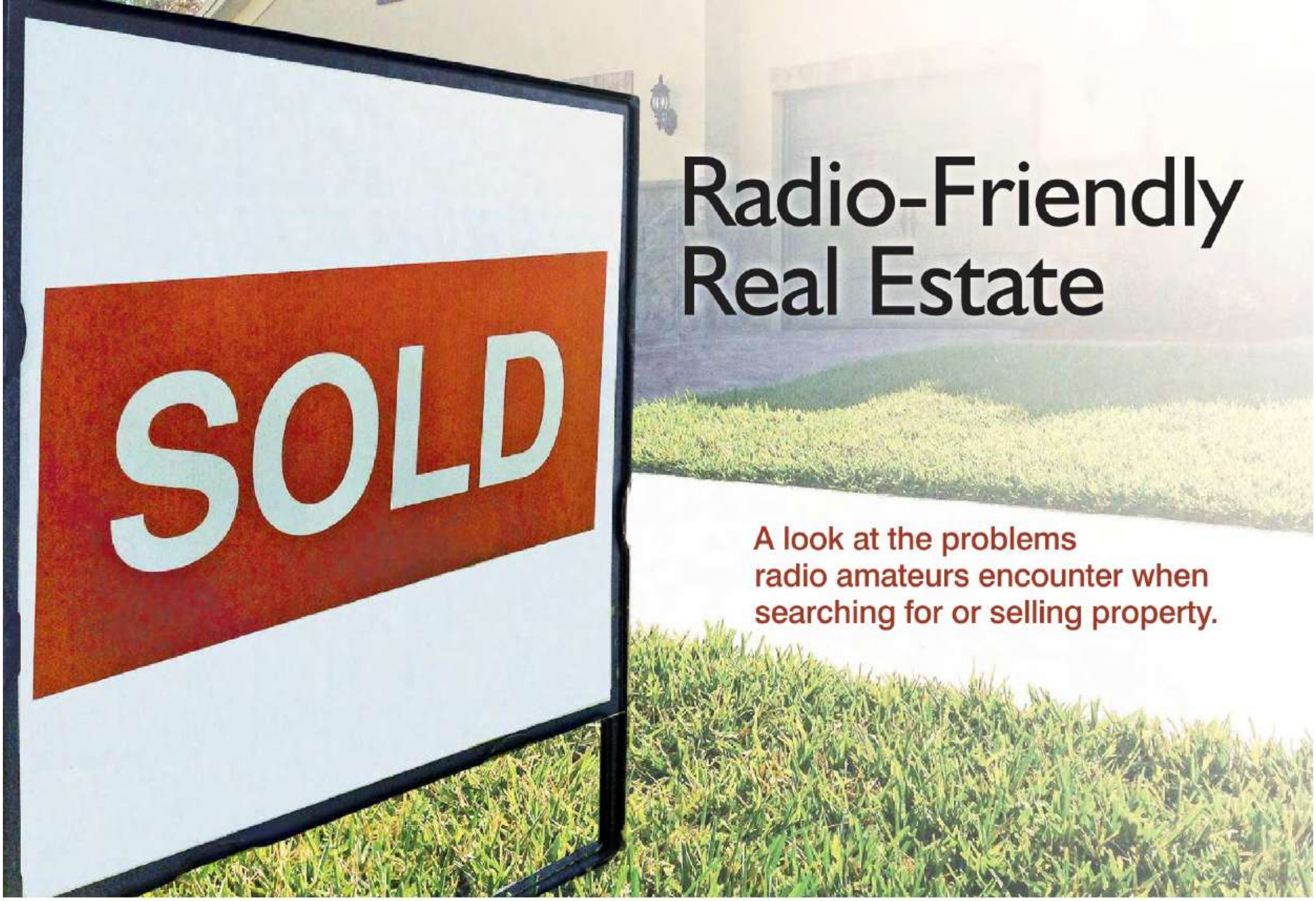
Photos by the author unless otherwise stated.

ARRL Life Member Bob Bruninga, WB4APR, holds an Amateur Extra-class license. Bob developed automatic packet reporting systems (APRS), and is the US Naval Academy's Aerospace Senior Research Engineer. He can be reached at **bruninga@usna.edu**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Radio-Friendly Real Estate

A look at the problems radio amateurs encounter when searching for or selling property.



[Photo courtesy of American Advisors Group (**aag.com**).]

Allison McLellan

Investing in the proper home is stressful enough, but for the radio amateur, stringent homeowners associations (HOAs), landlord regulations, and curious neighbors can pose additional problems for housing a station. A lot of equipment goes into building a custom amateur radio station — from power supplies and amplifiers to antenna towers, hams need the space to have it all.

Common Concerns

Property requirements for building antennas and housing technical equipment can be specific to radio amateurs, and many hams begin the process online, like in the Classifieds section of **eham.net**.

Florida resident Ron Maples, W3PV, posted on the website looking for a ham home in his area, specifically without an HOA and with enough room for his ham station and larger antennas. He had tried a few websites over the years that acted as an introduction service to real estate professionals who were also hams, but all of them eventually went offline.

"Realtors seem to overlook the importance of the ham radio activities I desired in my own home, and tried to talk me into some other properties," Ron explained.

To overcome a similar issue, Texas resident and retired US Air Force Lieutenant Colonel Mike Baker, W8CM, posted to the **eham.net** forum in search of realtors in his area who are also active hams to sell his home. He hoped a radio amateur realtor would most accurately represent the radio benefits offered by his current property, and could even communicate the benefits of an operation-ready home if a new ham wanted to move in.

"The general public…assumes that ham radio operation will be a source of interference. Antennas are often automatically regarded as unsightly; as a result, favorable ham operation is forced to the countryside," he said. Only after retirement was Mike able to be more selective about balancing his ham needs in order to find a ham-friendly property.

Hams on *House Hunters International*

Engineer Glen Kirkpatrick, W9LS/HK4LS, brought the struggles of finding radio-accommodating property to the small screen on a November 2018 episode of HGTV's *House Hunters International* with his wife, Teri, KD6CHK. The couple was moving from California to Medellín, Colombia, and the episode featured a discussion of Glen's considerations for housing radio equipment in rural and city-centric homes. In the end, the pair decided on an apartment in the city with a private rooftop deck and office space for antennas and equipment.

Now Glen is building a radio-friendly rental property up the Caribbean coast of Colombia. He plans to feature a tower with a tribander and vertical antenna with saltwater ground plane on the beachfront property. In between construction trips, he was able to give *QST* a look into his property search experience.

The *House Hunters International* crew filming Glen, W9LS/HK4LS, at his California station. [Glen Kirkpatrick, W9LS/HK4LS, photo]

Q How does ham radio fit into your life?

A Ham radio has been a big part of my life for 50 years. I was first licensed at age 11, and it was the most interesting thing I had ever seen. I was fascinated by how it all worked and had my Amateur Extra-class license by high school. College was, of course, focused on electrical engineering. I've been a consultant for the last 20 years, which affords the flexibility to live this sort of weird intercontinental life.

Q How did the crew of *House Hunters International* react to your interest?

A The director was a really interesting fellow who directs documentaries, TED Talks, and all sorts of cool stuff, but had never heard of ham radio. He was having trouble wrapping his head around my [attitude of], "Sure, it's an amazing downtown three-level penthouse in a gorgeous tropical city for the price of a garage in Los Angeles, but if I can't put up an antenna, no deal."

On the other hand, the audio guys — who have to design and build their own VHF-based audio distribution/camera syncing networks — thought my station was fascinating.

Q What did you film of your station and operating for the show?

A We spent about 3 hours filming in the shack. The video guys were phenomenal. For one shot, they stopped the lens down to minimize depth of field, then panned the focus across my Drake 7-Line, ending up on my [Drake] TR7A transceiver. It made the hairs on my arms stand up. Only a tiny fraction of the footage made it to the episode.

For operating, they liked my [FlexRadio] FLEX-6300 because of the dancing panadapter display. I had KJ7S in Utah teed up to make sure I could get some on-air chatter. The director was looking for maximum use of phonetics, Q-signals, jargon, and the use of the word "Colombia."

Q How did the radio setup at your new home work out?

A So far, I have shuttled a transceiver, power supply, antenna tuner, coax, and wire down here. When finished, I will have a vertical for 10 – 20 meters and a long wire across the roof down to a balcony for the low bands. The walls are all steel-reinforced concrete, so running coax will be a civil engineering project.

Q Can you speak to a ham's experience trying to find or sell radio-friendly property?

A I'm sure it varies widely by region. My experience is just in Colombia. Some things are the same everywhere. It's difficult to have a tower if you live in an apartment. Here, people don't seem to have any particular bias against antennas and still think that they are kind of cool.

You are generally dealing with a real estate agent that has no idea what your unique requirements are. If you give them a clear set of specifications, like unrestricted roof access for apartments, or [that] there can't be any rules against antennas or towers for other properties, they will do their best to find something that will work.

Another benefit ham radio offers is the ability to start sending emails to local hams, and they will respond.

Q Why did you decide to build a new property up the coast?

A Necoclí is an undiscovered (and affordable) beach town on the Caribbean coast. Road improvements and a new international airport will soon put it on the map, and it will pay for itself over time.

In the meantime, the lack of tower restrictions and ability to put a vertical antenna right in the saltwater offers an almost too-good-to-be-true ham radio situation. I will be able to put out a much more muscular signal from Necoclí than I ever could from my apartment in Medellín, and then operate it remotely from anywhere.

Creating the Resources

Scott Neader, KA9FOX, runs the Ham Radio Classified Ads at **QTH.com**. After numerous hams asked to promote their home on **QTH.com**, he realized there was a clear need for a dedicated website to help connect ham real estate sellers with ham buyers. In early 2018, he created **HamRadioHomes.com**.

"By selling a 'ham-friendly' home to another ham, the seller saves a huge amount of time in taking down towers and antennas, and hopefully can actually recover some of their investment, because the ham buying the property would see value in owning the towers and other equipment," Scott explained. "Buying a home with an existing tower virtually eliminates the headaches associated with putting up or decommissioning a tower, plus you have neighbors that are already used to having a tower nearby."

The website setup was relatively easy. Because he already owns the most popular online ham swap website, Scott has the available web hosting server space and can promote across **QTH.com**.

When asked about tips for conducting a property search, Scott advised keeping an open mind. "Because there are relatively few homes being sold by hams at any given moment, your search may have to be a bit flexible," he said. "As compared to most real estate searches, you may need to compromise on location, price, amenities, etc., in order to find a home that is already ham-ready." He added that, besides antennas, many sellers also include rotors, cables, and even their radios, which can be negotiated in the transaction.

Coincidentally, after using **eham.net**, Mike Baker connected with Scott and set up a posting for his home on **HamRadioHomes.com**. "Within 24 hours of my property being listed on that site, I was contacted by a ham in California who was interested in moving back to Texas. I provided some introductory info and pictures, then referred him to my realtor," he described. While the transaction ultimately didn't pan out, Mike has been satisfied with Scott's responsiveness. "He is providing a very badly needed service to supplement the traditional real estate system, which has no good mechanism to emphasize ham radio-friendly properties," he said.

A Local Community

Hams must also contend with varying laws and regulations relating to equipment, depending on the region they are moving to or selling in. To understand the legal minutiae of the real estate process, Scott recommends *Antenna Zoning for the Radio Amateur* by Fred Hopengarten, K1VR, which addresses potential issues ranging from permit obtainment, safety concerns, environmental problems, and neighbor objections.

Of course, the best resource for any ham looking to relocate is fellow hams. Local clubs are full of people who understand the house hunting predicaments for a ham better than anyone else. Western New York ARRL Official Observer Coordinator Paul Kolacki, K2FX, who posted online looking for property, said, "I have found it helpful to link up with ham operators in the potential areas for my [home station] to find out what club activities exist, speak with locals about some of the regulations pertaining to tower site infrastructure, and have them keep an eye out for potential new properties as they come up for sale."

The house hunting process can be discouraging, but many have been there before, and the amateur radio community can always be depended upon to offer guidance and support.

Mike Baker, W8CM, listed his Texas property, including his three antenna towers, on **HamRadioHomes.com**. [Mike Baker, W8CM, photo]

Allison McLellan can be reached at **almmclellan@gmail.com**.

Easy Super Stealth Antenna

Dennis Lazar, W4DNN

At a meeting of our local radio club, Peter, K4PJG, a newly minted General-class licensee, was sharing his struggles living in a deed-restricted community with a homeowners association (HOA) that prohibits antennas of any kind. He'd only been able to operate portable while on trips in his camper.

Dave, K4DES, suggested that he might run a thin wire from the side of his home to a nearby tree, but even that would be too visible for the strict HOA rules. Always up for a challenge, I volunteered to put together a truly invisible antenna for Peter.

Design Plan

Like my own roof, Peter's uses barrel tiles. Unlike asphalt shingles, the tiles stand off the roof structure by about 3 inches, are non-conductive, and do not absorb moisture. The ideal invisible antenna, I thought, would be an end-fed random wire in the same color as the roof. Simply draped across the roof, it should blend in with the texture and complex pattern of the tiles, rendering it virtually invisible. But I was unsure about what kind of RF pattern this antenna would produce. I had read that very low wire antennas might have omni-directional patterns and not be entirely NVIS (near-vertical incidence skywave).

At the time, I was also interested in a second antenna for my own home station, so I used my home to experiment with setups to help Peter. Our homes, like many in Florida, are constructed of concrete block covered by stucco. The outer stucco finish is a type of plaster secured to the outside surface of the block by a fine aluminum grid. This results in the house becoming a perfect Faraday box. RF has a very difficult time getting in or out. Therefore, there is no reception. The new antenna had to be outside the structure and low enough not to be a good conductor for lightning.

Construction

In the garage, I had a 40-meter dipole, but due to a 2004 hurricane, I no longer had trees. So, I repurposed the black-jacketed 14-gauge stranded wire by simply draping 44 feet of it across the roof, securing it at each end with black Dacron cord and attaching a length of RG-58U coax long enough to reach the shack (see Figure 1).

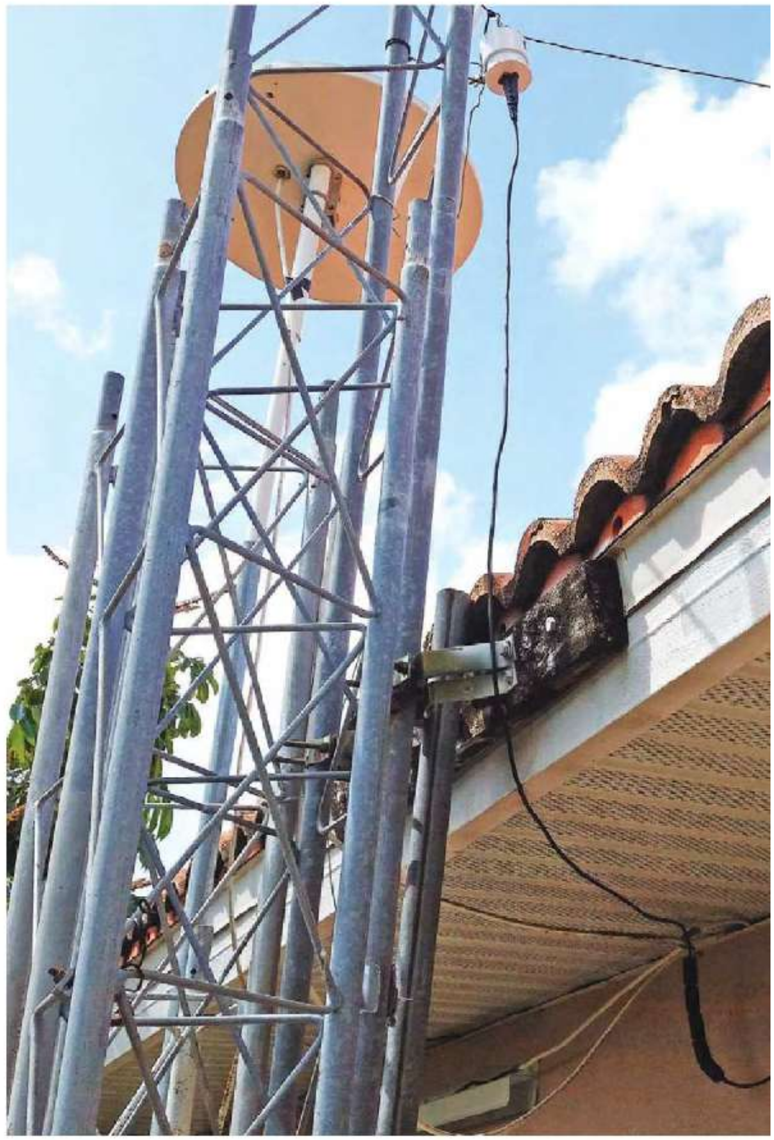


Figure 1 — My antenna arrangement. I do not live in a deed-restricted community so the unun does not need to be invisible.

To arrive at the optimal wire length for a random wire antenna for the ham bands, I assessed a range of wire lengths to fit the available space. Any length chosen must be far from being resonant on any of the ham bands. By using a random, non-resonant wire and a tuner, the antenna will be multiband.

Once the wire was on the roof, I listened to 20 meters. As a receiving antenna — despite the tremendous impedance mismatch — reception was fantastic. Now I needed to transmit. This would require a 9:1 unun

A random-wire antenna that's easy to put together — and easy to hide if you live with an HOA.

(an impedance transformer from unbalanced line to unbalanced antenna), which would probably be easy to build, but I elected to buy one.

The final arrangement is simple. The unun is tied to my TV antenna tower with some Dacron cord. It attaches to the end of the wire, which is draped across the roof. I added a 30-foot length of counterpoise wire that runs down the side of the house and along the concrete footer parallel with the roof and antenna. It is positioned on the concrete so as not to touch actual ground. I clamped five ferrites around the coax where it hangs below the roof. This and the counterpoise wire keep the antenna from using the coax shield as a counterpoise, which would bring RF into the house.

Figure 2 — Peter, K4PJG, prepares to deploy the invisible antenna wire, which is secured at one end to the TV dish.

Peter has been working the world with the neighbors blissfully unaware that there is now a ham operating in the neighborhood.

Testing the Setup

Once deployed, I fired up the rig in the shack on 20 meters and prepared to adjust my antenna tuner for minimum SWR. Before starting to tune, I called CQ at 5 W. Immediately, Pat, VE3DZZ, in Ontario, came back and gave me a 439. A few minutes later, after achieving a match at 1.2:1, and upping the power to 90 W, I made contacts across the US and as far as Cuba and Croatia. The antenna did not seem to be very directional.

To conduct a more objective test, I used the Reverse Beacon Network to monitor the bands and generate a list of the stations that have heard me. I called VVV de W4DNN six times using my vertical, with 14 replies. Using the rooftop wire, I received reports from 11 stations. Each station provided the signal-to-noise ratio of the received signal. The test results showed that most stations who heard me with the vertical also heard me with the wire, but at reduced strength.

Responding stations were located in Washington, Texas, Kansas, Wisconsin, Ohio, Massachusetts, New Hampshire, Arizona, Colorado, North Carolina, Calgary, and Quebec. The only responding DX station was from Belize, and only the wire antenna was heard. The band was not open into Europe.

Applying the Research

With my research finished, we got to work on Peter's stealth antenna. Because Peter's tile roof is white, he acquired white wire, white Dacron line, and a white 9:1 unun.

We positioned the unun near the shack window, lying flat on the roof and draped the wire across, toward the far side of the house, securing it with Dacron line. From the road and from any point around the house, the antenna is totally invisible, even up close (see Figure 2). Because one end of the wire is secured to the satellite TV antenna, it appears to be part of the TV installation.

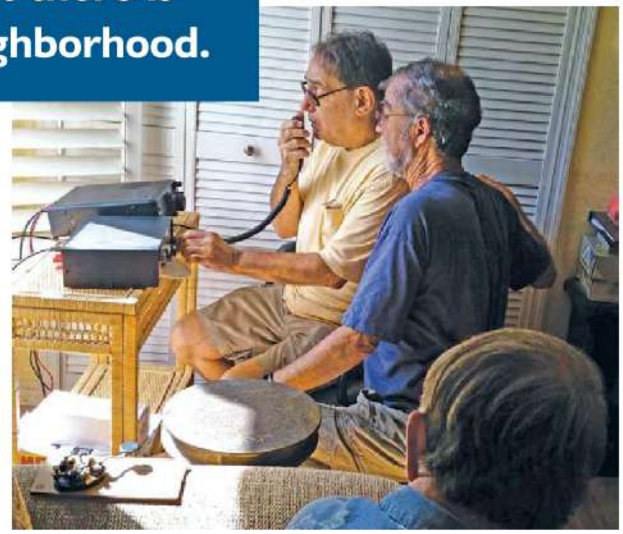


Figure 3 — Following tune-up, Angelo, K3YUN, called the first CQ with Peter anxiously observing.

On The Air

Once deployed, it was time to get the new antenna on the air. Angelo, K3YUN, used his antenna analyzer to tune the wire to a perfect 1:1 match on 20, 40, and 80 meters. A few days later, a great contest weekend provided several perfect opportunities to work many stations in the US and DX as well (see Figure 3).

In the weeks following, Peter has been working the world, mainly on 20 and 40 meters, with the neighbors blissfully unaware that there is now a ham operating in the neighborhood.

All photos by the author.

Dennis Lazar, W4DNN, has been licensed since 1960. After leaving the Coast Guard, he worked with NASA on the Apollo moon exploration project. Turning to journalism, he was associate editor of two trade magazines and later, editor and publisher of a weekly neighborhood newspaper. Returning to college, he became a registered nurse therapist and then doctor of naturopathy, working in a private pain-management practice until 2008. Dennis holds an Amateur Extra-class license and a general commercial license. He has served as QRP editor for *CQ* Magazine, and has written many articles for *73*, *CQ*, and *QST* magazines.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Rick Lindquist, WW1ME, ww1me@arrl.org

Happenings

FCC Amending Amateur Radio RF Exposure Safety Rules

The FCC is amending its Part 97 Amateur Service rules relating to RF exposure safety. In ET Docket 19-226, the FCC said current amateur radio RF exposure safety limits will remain unchanged, but it's replacing the amateur-specific exemption from having to conduct an RF exposure evaluation with its general exemption criteria. Radio amateurs have always had to comply with RF exposure limits, but certain stations have been exempt from having to conduct evaluations based only upon power and frequency. The new rules were expected to take effect early this year.

Members of the ARRL Board's Executive Committee traveled to Washington, DC, in early November to meet with FCC personnel. From left to right: Atlantic Division Director Tom Abernethy, W3TOM; ARRL President Rick Roderick, K5UR; West Gulf Division Director John Robert Stratton, N5AUS; Roanoke Division Director Bud Hippisley, W2RU; New England Division Director Fred Hopengarten, K1VR, and ARRL Washington Counsel David Siddall, K3ZJ.

"For applicants and licensees in the Amateur Radio Service, we substitute our general exemption criteria for the specific exemption from routine evaluation based on power alone in Section 97.13(c)(1) and specify the use of occupational/controlled limits for amateurs where appropriate," the FCC said.

ARRL Lab Manager Ed Hare, W1RFI, commented in December, "The major aspects of the rules will not impose major new burdens on the Amateur Radio Service. As in all regulatory matters, though, the devil may be in the details, so the ARRL technical staff, legal staff, and the experts on the ARRL RF Safety Committee are carefully evaluating this FCC document."

Under the revised Section 97.13(c)(1), "In lieu of evaluation with the general population/uncontrolled exposure limits, amateur licensees may evaluate their operation with respect to members of his or her immediate household using the occupational/controlled exposure limits in Section 1.1310, provided appropriate training and information has been accessed by the amateur licensee and members of his/her household," the amended rule says.

"RF exposure of other nearby persons who are not members of the amateur licensee's household must be evaluated with respect to the general population/uncontrolled exposure limits. Appropriate methodologies and guidance for evaluating Amateur Radio Service operation is described in the Office of Engineering and Technology (OET) Bulletin 65, Supplement B," the revised rule concludes.

The FCC said it was not persuaded by ARRL's argument in its comments that the routine evaluation exemption for amateur radio stations operating below a certain power threshold should be maintained. "Amateur radio licensees operate a variety of installations of different size, power, and frequency, which can be located in close proximity to people, giving rise to various RF exposure concerns," the FCC noted.

Meeting with FCC OET Chief Julius Knapp and senior staff in early November, ARRL asked the FCC to make available on the internet a calculator to facilitate making the correct calculations the rules require.

ARRL Asks FCC to Dismiss Petition Seeking Declaratory Ruling on Encoded Message Rule

ARRL has asked the FCC to dismiss a *Petition for Declaratory Ruling* filed by New York University (NYU), that, in ARRL's view, proposes a new interpretation of Section 97.113(a)(4), which prohibits "messages encoded for the purpose of obscuring their meaning." In its December 2 filing, ARRL said NYU's call to "clarify" the rule's meaning to prohibit "effectively encrypted or encoded messages, including messages that cannot be readily decoded over the air for true meaning," is not only vague but could weaken the prohibition against encryption.

In its comments and in face-to-face meetings with FCC personnel, ARRL pointed out that the FCC rule prohibiting "messages encoded for the purpose of obscuring their meaning," is essentially the same language that appears in the International Telecommunication Union (ITU) *Radio Regulations* applying to all countries. ARRL continues to support rules prohibiting encrypted messages on the amateur bands, even for limited emergency communication purposes, and the ARRL Board reiterated that opposition last July.

NYU has not presented any information to demonstrate that the FCC's current rule is not being complied with by digital innovators, ARRL said, and adoption of NYU's petition would create more questions for the FCC than it would be able to answer if called upon to apply the petition's vague language in specific cases.

ARRL Announces Opposition to Elimination of 3.3 – 3.5 GHz Amateur Allocation

ARRL will oppose the FCC's proposed removal of the amateur radio 9-centimeter allocation at 3.3 – 3.5 GHz in WT Docket 19-348, "Facilitating Shared Use in the 3.1 – 3.55 GHz Band."

"This *Notice of Proposed Rulemaking* (NPRM) would propose to remove the existing non-federal allocations in the 3.3 – 3.55 GHz band as a step toward potential future shared use between federal incumbents and commercial users," an FCC *Fact Sheet* explained. "By taking the initial step needed to clear the band of allocations for non-federal incumbents, the Commission furthers its continued efforts to make more mid-band spectrum potentially available to support next generation wireless networks."

The *NPRM* proposes to clear the 3.3 – 3.55 GHz band of existing non-federal users by removing *non-federal secondary radiolocation and amateur allocations* [emphasis added] in the 3.3 – 3.55 GHz band and to relocate incumbent non-federal users out of the band. The FCC planned to seek comment on relocation options either to the 3.1 – 3.3 GHz band or to other frequencies. The FCC *NPRM* asked whether existing amateur spectrum in other bands might support operations currently conducted in the 3.3 – 3.5 GHz band.

Alaska and Tennessee Have New Section Managers

New Section Managers (SMs) were elected in the fall 2019 election cycle in Alaska and Tennessee. Eight incumbents ran without opposition.

In a very close race in Alaska, David Stevens, KL7EB, received 98 votes, and his opponent, Lara Baker, AL2R, received 88 votes. Stevens served previously as Alaska's SM, from 1984 until 1985; from 1998 until 1999, and from 2002 through 2007. He takes over from Ray Hollenbeck, KL1IL, who led the Alaska Section for 4 years and did not seek another term.

In Tennessee, David Thomas, KM4NYI, outpolled Charles Talley, KJ4KVC, 557 to 417. Thomas succeeds Keith Miller, N9DGK, who did not run for a new term after serving since 2012.

These incumbent SMs were the only candidates in their respective Sections and have been declared elected. JVann Martin, W4JVM (Alabama); Bill Duveneck, KB3KYH (Delaware); Jim Siemons, W6LK (East Bay); Ron Cowan, KBØDTI (Kansas); Jim Kvochick, K8JK (Michigan); Bill Mader, K8TE (New Mexico); John Kitchens, NS6X (Santa Barbara), and Ray Lajoie, KB1LRL (Western Massachusetts).

New terms began on January 1.

ARRL Southeastern Division Leadership Changes

A new ARRL Director and Vice Director took office on January 1 in ARRL's Southeastern Division. The vote saw Mickey Baker, N4MB, defeating incumbent Director Greg Sarratt, W4OZK, 2,132 votes to 1,739 votes. In addition, challenger James Schilling, KG4JSZ, received 1,356 votes to win a three-way race for Vice Director, outpolling incumbent Joseph Tiritilli, N4ZUW, who received 1,209 votes, and challenger Jeff Stahl, K4BH, with 1,281 votes.

In the only other contested race, incumbent West Gulf Division Director John Robert Stratton, N5AUS, defeated challenger Madison Jones, W5MJ, for re-election, by a vote of 2,498 to 1,405. Stratton moved into the Director's seat last January after past Director David Woolweaver, K5RAV, stepped down. West Gulf Division Vice Director Lee Cooper, W5LHC, was unopposed for a full term after being appointed earlier this year to succeed Stratton.

In Brief...

■ **Melissa Stemmer has joined the ARRL Headquarters staff as Development Manager.** Stemmer holds a BS in pharmacy from the University of Connecticut and worked in that field for more than 15 years before changing careers. She earned a Master's in organizational leadership in 2015 from Quinnipiac University. Before coming to ARRL, Stemmer was the Development Director at Seven Angels Theatre in Waterbury.

■ **ARRL has launched a new podcast lineup, in conjunction with the debut of its new *On the Air* magazine for newcomers.** A free companion "On the Air" podcast takes a deeper look into select features from the magazine launched in January. A free "On the Air" blog features content from the people who are the driving force in amateur radio today. Readers are invited to take part in the conversation via email, **ota-blog@arrl.org**. The "So Now What?" podcast ceased production in January, but episodes remain available. "The Doctor is In" podcast also concluded its 4-year run in December, but a complete archive is available. "Eclectic Tech," a new bi-weekly podcast for experienced amateurs, will launch this month, with host *QST* Editor Steve Ford, WB8IMY, highlighting technical topics.

■ **Melissa Pore, KM4CZN, of Vienna, Virginia, is the 2020 recipient of the Carole Perry Educator of the Year Award.** Sponsored by Orlando HamCation, the award recognizes outstanding contributions in educating and advancing youth in amateur radio. It was first awarded in 2018 to its namesake, veteran educator Carole Perry, WB2MGP. Pore is an Amateur Radio on the International Space Station (ARISS) Education Committee member and an ARISS ambassador. An educational professional for more than 20 years, Pore teaches engineering and computer science at an Arlington, Virginia, high school and is involved in the school's amateur radio and engineering clubs. While an elementary school teacher, Pore was associated with the STMSAT-1 project. She assisted with the Dayton Hamvention 2019 ARISS booth and helped staff the exhibit at the Space Explorers Education Conference last February in Houston, Texas, where she's set to present a workshop in 2020.

■ **University of Scranton Professor Nathaniel Frissell, W2NAF, has won a $1.3 million National Science Foundation (NSF) grant.** Frissell will study weather effects in the ionosphere by leveraging a network of amateur radio stations. Perhaps best known within the amateur radio community as the founder of HamSCI, the Ham Radio Science Citizen Investigation initiative, Frissell will implement his Distributed Arrays of Small Instruments (DASI) project over 3 years. As principal investigator, Frissell — a space physicist — will head a collaborative team that will develop ground-based space science observation instruments and software.

■ **Past ARRL Chief Technology Officer Paul L. Rinaldo, W4RI, of Burke, Virginia, died on November 29.** An ARRL Life Member, Rinaldo was 88. First licensed in 1949 as W9IZA, Rinaldo was a cofounder and served as president of the Amateur Radio Research and Development Corporation (AMRAD). He was the first editor of *QEX*. In 1983, Rinaldo succeeded Doug DeMaw, W1FB, as ARRL Technical Department Manager and Senior Technical Editor, and he later became Publications Manager and Manager of Technical Development. Rinaldo also took part in several International Telecommunication Union (ITU) conferences and served on numerous working parties and task groups. International Amateur Radio Union (IARU) Secretary David Sumner, K1ZZ, said amateur radio's successes at WRC-19 were in large part due to Rinaldo's good work over the years. In 1992, Rinaldo established ARRL's Technical Relations Office, and in 2003 the ARRL Board elected Rinaldo as ARRL's first Chief Technology Officer. He retired in 2008.

WRC-19 Delegates Reach Agreement on 6 Meters in ITU Region 1

World Radiocommunication Conference 2019 (WRC-19) approved a 6-meter allocation for International Telecommunication Region 1 (Europe, Africa, and the Middle East). The decision came after more than 2 weeks of strenuous negotiations to reconcile widely disparate views of Region 1 administrations. When the *Final Acts* take effect next year, 44 countries in Region 1 will have a primary allocation of at least 500 kHz, including 26 countries with a primary allocation of 50 – 54 MHz. The entire region will have an amateur secondary allocation of 50 – 52 MHz, except in Russia, whose administration opted for only 50.080 – 50.280 MHz on a secondary basis.

The existing primary allocation of 50 – 54 MHz in Regions 2 and 3 is unaffected. The decision on WRC-19 agenda item 1.1 is the culmination of years of effort by the International Amateur Radio Union (IARU).

Sponsored by the International Telecommunication Union (ITU), WRC-19, which wrapped up on November 22, was the largest ever, with some 3,300 delegates in attendance.

Dayton Hamvention® Announces Theme, New Rates and Fees for 2020

The theme will be "Amateur Radio, the Future" when Dayton Hamvention 2020 takes place May 15 – 17 at the Greene County Fairgrounds and Expo Center in Xenia, Ohio. Hamvention General Chair Jack Gerbs, WB8SCT, cited "the diversity of the modes available today."

In early December, Gerbs also announced that general admission would rise by $4 per ticket to $26 in advance or $31 at the gate. The cost of flea market spots will go up by $5 per space, and inside exhibitors will pay $30 more.

"Hamvention has always strived to produce a very high-quality event for amateur radio enthusiasts from around the globe," Gerbs said. He cited "economic pressures" as the reason for the price increases.

Nominations for Hamvention's 2020 awards are due by February 15 for Amateur of the Year, Club of the Year, Technical Achievement, and Special Achievement. For more information, contact the Dayton Hamvention Awards Committee at **awards@hamvention.org**.

Section Manager Nomination Notice

To all ARRL members in Illinois, Indiana, Maine, Northern Florida, Oregon, Santa Clara Valley, Vermont, and Wisconsin: You are hereby solicited for nominating petitions pursuant to an election for Section Manager (SM). Incumbents are listed on page 16 of this issue.

To be valid, a petition must contain the signatures of five or more full ARRL members residing in the Sections concerned. It is advisable to have a few more than five signatures on each petition. A sample nomination form is available on the ARRL website at **www.arrl.org/section-terms-nomination-information**. Nominating petitions may be made by facsimile or electronic transmission of images, provided that upon request by the Field Services Manager, the original documents are received by the manager within 7 days of the request.

We suggest the following format:

(Place and Date)

Field Services Manager, ARRL
225 Main St.
Newington, CT 06111

We, the undersigned full members of the ______ ARRL Section of the ______ Division, hereby nominate ______ as candidate for Section Manager of this Section for the next 2-year term of office.

(Signature____ Call Sign____ City____ ZIP___)

Any candidate for the office of Section Manager must be a resident of the Section, an amateur radio licensee of Technician class or higher, and a full member of ARRL for a continuous term of at least 2 years immediately preceding receipt of a nominating petition. Petitions must be received at Headquarters by 4 PM Eastern Time on March 6, 2020. If more than one member is nominated in a single Section, ballots will be mailed from Headquarters no later than April 1, 2020 to full members of record as of March 6, 2020, which is the closing date for nominations. Returns will be counted May 19, 2020. Section Managers elected as a result of the above procedure will take office July 1, 2020.

If only one valid petition is received from a Section, that nominee shall be declared elected without opposition for a 2-year term beginning July 1, 2020. If no petitions are received from a Section by the specified closing date, such Section will be resolicited in the July *QST*. A Section Manager elected through the re-solicitation will serve a term of 18 months. A Section Manager vacancy occurring between elections is filled through appointment by the Field Services Manager. — *Bart Jahnke, W9JJ, Field Services & Radiosport Department Manager*

Cathy Etheredge, N7HVN, n7hvn@arrl.net

Public Service

Nevada ARES Supports "Storm Area 51" Festival

In September 2019, what started as a social media joke to "Storm Area 51," spiraled into emergency declarations in two Nevada counties as 3.5 million people expressed interest in attending such an event. Several subgroups were created, promoting a huge music festival dubbed "Alienstock." With limited resources, personnel, and infrastructure, authorities were prepared to handle 30,000 visitors at most, so the anticipation of such huge crowds was alarming. Nevada Section Manager John Bigley, N7UR, called it an "activation of unknowns" that offered excellent practice and training during an authentic situation for radio amateurs to get involved and offer communications support.

Figure 1 — The map of the area delineates the extensive operational area covered by the ARES team.

Setup

Lincoln County Sheriff Kerry Lee and Emergency Manager Eric Holt activated the Amateur Radio Emergency Service (ARES) in Lincoln County, with requests made for assistance from Clark and Nye Counties. On Tuesday, September 17, 2019, amateur radio operators deployed to provide communication support for the "Alienstock" gathering in Rachel, Nevada, and the "Storm Area 51" event in Hiko, Nevada, which ran through Sunday, September 22, 2019 (see Figure 1).

On Wednesday, September 18, 2019, the Clark County Mobile Communications Vehicle (MCV) was set up at the ICP (Incident Command Post) in Tickaboo Valley (see Figure 2). The MCV contained six positions with radios that were programmed to the ICS 205 frequencies. To ensure communications with the ICP, the ARES team used Winlink, set up an HF station, and UHF stations were placed on Coyote Summit (5,604-foot elevation) and on Handcock Summit (5,594-foot elevation).

Alienstock

The majority of attendees were there for the alien-themed music festival, called "Alienstock," which took place in Rachel, Nevada, along the "Extraterrestrial Highway." With so many attendees in such a remote location and no internet or cell phone coverage, it was incumbent to maintain voice communication with the ICP.

In Rachel, ARES operations joined law enforcement and medical teams that were all set up in D.C. Day Park. The ARES team had a mobile communications center with complete suite of equipment, including multiple VHF and UHF transceivers set to the frequencies provided on the ICS 205. The ARES team set up three local HF radios, as well as one for digital communications. Two dipole antennas and one 100-foot wire with auto tuner were set up for HF radios. A J-pole antenna on a 15-foot pole was used for VHF and a beam antenna on another pole for UHF. Additionally, HF equipment was backed up by a remote system in Las Vegas.

Because their position afforded a distant view of the road to the Area 51 back gate, the operators logged 400 hours of continuous coverage on all frequencies to monitor and report on incoming and outgoing cars.

Alamo

At the Pahranagat Valley High School in Alamo, Nevada, another ARES base of operations was set up with a mobile radio station with VHF, UHF, HF, packet, and Winlink capability. A 40/80 meter dual-band HF NVIS antenna was set up to facilitate a strong HF signal into the ICP. Both the Tickaboo Valley and Rachel radios were able to communicate with the VHF Alamo repeater. The high school was also used as a staging area for supplies, such as water, food, fuel, and electricity generators.

Storm Area 51

On Tuesday, September 17, the Hiko Command was set up directly across the highway from the infamous "Alien

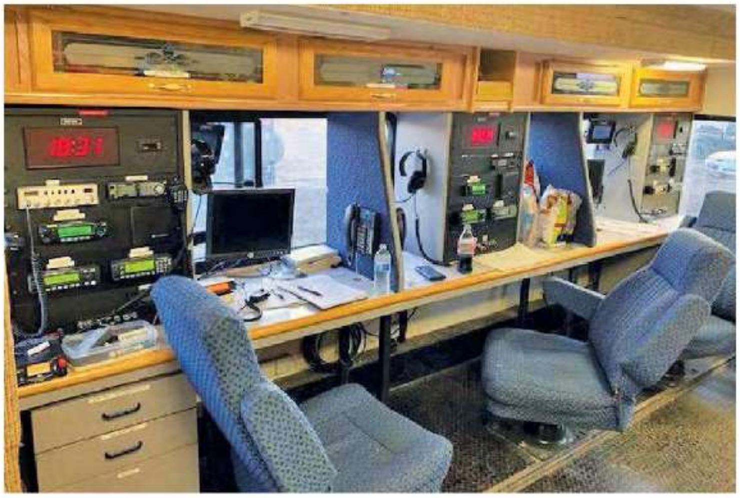


Figure 2 — Clark County Mobile Communications Vehicle (MCV) stationed at the Incident Command Post (ICP) in Tickaboo Valley, Nevada. [Jimmy Gollahon, AA4Z, photo]

Research Center," again sharing the staging location with medical and law enforcement teams.

ARES Command took place out of the garage of an RV and an enclosed utility trailer as a deployable ham radio shack. Because the Hiko site had no power or potable water, the operating team was able to practice resource management. Through the use of batteries, solar panels, and generators, the operators quickly established communications via VHF repeaters, HF SSB, HF digital (Winlink), and digital mobile radio (DMR) through a digital voice access point dongle and a Wi-Fi hotspot.

The Hiko location utilized an off-center-fed 6 – 80 meter Windom and a 6 – 80 meter vertical antenna for HF and two dual-band base station antennas for VHF/UHF. Primary voice communications within the event location was the Alamo repeater and peer-to-peer (P2P) Winlink. Communications beyond the local area was conducted via P2P Winlink and Winlink gateway stations.

In addition to the hams in and around the event area, Clark County ARES members were called into action to staff the Clark County Emergency Communication Center (ECC) to monitor the event. From this location, the system permitted communications with both the Regional Emergency Operations Center in Reno and the Nevada Department of Emergency Management in Carson City.

A Successful Operation

The ARES team was operational and ready to handle all communications and concerns. The ARES deployment plan took into account all the available resources, timeline constraints, and allowed for scaling up or down as required, based on the eventual number of attendees, which turned out to be only 3,000 people. Still, Lincoln County EC, Charles "Chuck" Reifsnyder, AD7OY, said the operation offered a unique set of challenges, including rough winds, the operation size (53 miles and two mountain ranges), strength problems, and internet and cell phone coverage issues. But Chuck was proud of the operators, saying, "With strategic placement of portable repeaters, they were able to address the environmental issues with skill and professionalism to provide up-to-date information."

Field Organization Reports

November 2019

Public Service Honor Roll

This listing recognizes radio amateurs whose public service performance during the month indicated 70 or more points in six categories. Details on the program can be found at **www.arrl.org/public-service-honor-roll**.

540
KD8TTE

375
N9VC

345
WA3EZN

343
W7PAT

270
WØPZD

260
KW9EMG

242
KD2LPM

240
KT2D

235
W9GRG

232
KE8BYC

231
AD8CM

230
K1XFC

218
WM2C

216
ALØY

200
N8SY
KK4PUX
WD8USA

191
N3KRX

185
WC9CW
WO2H

180
KØIBS
WB9WKO

170
NI2W
WD8MWD

160
WA2CCN
WB8RCR

155
ACØKQ

154
KI4UDZ

153
WA2BSS

150
KD8UUB
KB8PGW

147
N2WGF

143
KB2YRU

140
K4IWW
W4DNA
W5DY

135
W3YVQ

130
WB9QPM
N2JBA
N2TSO
KW1U
NA7G

129
K3FAZ

125
W3GWM
AG9G
NX9K
N5MKY

123
KA8ZGY

122
KT5SR

121
AD3J

120
WA4VGZ
KC8WH
KY2D
W7EES
WK4WC
WØLAW
K9LGU
K3JL
N7IE
K8ED

115
N1TF

113
KA2HZP

111
W8DJG

110
W8IM
WB8YLO
K8LPC
N8CJS
WA2QLW
W1KX
W8IM
K3IN
N1IQI
W1RVY
KD2JKV
KA5AZK
K6HTN
KF5IOU
WB8TQZ

109
KC8YVF

106
N2DW
WB8YYS
N2DW
K2TV

104
K6JGL

103
KA9MZJ

100
AC8RV
KB2QO
NN7H
KD2MDV
WB3FTQ
N3JET
KI7TIG
KI7RPM
N1LAH
KN9P
KA5YTA
KG5NNA

97
KA2GQQ
KB5PGY

95
N3RB
KB1NMO

93
WB8QLT
KE1ML

92
KØEK
N3SW
K1HEJ
AB3WG
AA3SB

90
WB8SIQ
K8KRA
KD2EAQ
KB1NAL
KA1G
KB8HJJ
AA3N
W4TTO
KB8RCR
WB8WKQ
K8RDN

89
K8AMH

88
KD8ZCM
KE8CEH

87
K6JT

85
KN4AAG

84
KC1HHO

83
AC8NP

82
KBØDTI
KF7GC

80
KT4WX
KL7RF
KT4WX
KD2GRS
KB4CAU
AF2NC
NBØZ
KF7GC

76
W7MIN

75
WV5Q

74
KØFBS

73
KB3KYH
W5XX

72
KV8Z

71
KD2MEN
KC7ASA
AA7BM

70
N6IET

The following stations qualified for PSHR in previous months but were not reported in this column: (Oct.) KA9QCW 155, AB9ZA 150, N1LL 130, W9BGJ 102, K9UDR 99, WDØBFO 84, KAØDBK 78, WS4P 70. (Sept.) KW1U 130, N1TF 115, KE1ML, W1RVY, N1IQI, KD2JKV, KC1HHO 110, WA1LPM 90, N1LAH 78, WS4P 70.

Section Traffic Manager Reports

The following Section Traffic Managers reported: AL, AR, AZ, CO, CT, DE, EMA, ENY, EPA, IL, KS, LAX, MDC, ME, MI, MN, MS, NC, NLI, NM, NNJ, NTX, OH, OR, SD, STX, TN, UT, VA, WCF, WI, WMA, WPA, WV, WY.

Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: CT, DE, ENY, EPA, GA, IA, IL, IN, KY, LA, MDC, ME, MI, MN, MO, MS, MT, NLI, NM, NNJ, NNY, NV, OH, OR, PAC, SFL, SNJ, STX, SV, VI, WPA, WV, WWA, WY.

Brass Pounders League

TThe BPL is open to all amateurs in the US, Canada, and US possessions who report to their SMs a total of 500 or more points or a sum of 100 or more origination and delivery points for any calendar month. Messages must be handled on amateur radio frequencies within 48 hours of receipt in standard ARRL radiogram format. Call signs of qualifiers and their monthly BPL total points follow.

NX9K 1050, K6HTN 798, WB9WKO 779, N1IQI 612, KW1U 579.

The following stations qualified for BPL in previous months, but were not reported in this column: (Oct.) KØTQ 145 [originations plus deliveries]. (Sept.) KW1U 536.

Bruce Draper, AA5B, aa5b.corral@gmail.com

Contest Corral

February 2020

Check for updates and a downloadable PDF version online at **www.arrl.org/contests**.
Refer to the contest websites for full rules, scoring information, operating periods or time limits, and log submission information.

Start Date	Start Time	Finish Date	Finish Time	Bands	Contest Name	Mode	Exchange	Sponsor's Website
1	0000	2	2359	1.8-UHF	Vermont QSO Party	CW Ph Dig	RS(T), county or SPC	www.ranv.org/vtqso.html
1	0001	2	2359	28	10-10 International Winter Contest, SSB	Ph	Name, mbr or "0," SPC	www.ten-ten.org
1	1200	2	1159	1.8-28	Black Sea Cup International	CW Ph	RS(T), ITU zone, Black Sea club info (if any)	bscc.ucoz.ru
1	1200	2	1200	3.5-28, 144	F9AA Cup, CW	CW	RST, serial	www.site.urc.asso.fr
1	1200	2	2359	3.5-28	Mexico RTTY International Contest	Dig	RST, XE state or serial	www.rtty.fmre.mx
1	1400	1	2359	1.8-28	Minnesota QSO Party	CW Ph Dig	Name, county or SPC	www.w0aa.org
1	1400	1	2359	1.8-28	FYBO Winter QRP Sprint	CW Ph Dig	RS(T), SPC, name, power, temperature	arizonascqrpions.apps-1and1.com
1	1600	1	1900	3.5	AGCW Straight Key Party	CW	RST, serial, class, name, age	agcw.org/index.php/en
1	1600	2	2359	1.8-28	British Columbia QSO Party	CW Ph Dig	RS(T), BC District or SPC	orcadxcc.org/bcqp_rules.html
1	1700	1	2100	3.5-28	FISTS Winter Slow Speed Sprint	CW	RST, SPC, name, mbr or power	fistsna.org
2	0000	2	0400	3.5-14	North American Sprint, CW	CW	Other station's call, your call, serial, name, SPC	ncjweb.com
3	2000	3	2130	3.5	RSGB 80-Meter Club Championship, SSB	Ph	RS + serial	www.rsgbcc.org/hf
4	0200	4	0400	3.5-28	ARS Spartan Sprint	CW	RST + SPC + Power	arsqrp.blogspot.com
5	2000	5	2100	3.5	UKEICC 80-Meter Contest	Ph	4-char grid square	www.ukeicc.com
6	1800	6	2200	28	NRAU 10-Meter Activity Contest	CW Ph Dig	RS(T), 6-char grid square	nrau.net/activity-contests
6	2000	6	2200	1.8-50	SKCC Sprint Europe	CW	RST, SPC, name, mbr or power	www.skccgroup.com
8	0000	9	2359	3.5-28	CQ WW RTTY WPX Contest	Dig	RST, serial	www.cqwpxrtty.com
8	1000	9	1000	1.8-28	SARL Field Day Contest	CW Ph Dig	RS(T), number of xmtrs, category, province or "DX"	www.sarl.org.za
8	1100	8	1300	7, 14	Asia-Pacific Spring Sprint, CW	CW	RST, serial	jsfc.org/apsprint/aprule.txt
8	1200	9	1200	1.8	KCJ Topband Contest	CW	RST, JA Prefecture/District code or continent	www.kcj-cw.com
8	1200	9	1200	1.8-28	Dutch PACC Contest	CW Ph	RS(T), province or serial	pacc.veron.nl
8	1200	9	2359	1.8-50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
8	1400	10	0200	All (no WARC)	YLRL YL-OM Contest	CW Ph Dig	Serial, RS(T) SPC	ylrl.org/wp/yl-om-contest
8	1500	9	1500	1.8-28	OMISS QSO Party	Ph	RS, SPC, mbr (if any)	omiss.net/Facelift/qsoparty.php
8	1700	8	2100	3.5-28	FISTS Winter Unlimited Sprint	CW	RST, SPC, name, mbr or power	fistsna.org
8	1900	8	2300	1.8	RSGB 1.8 MHz Contest	CW	RST, serial, District code (if any)	www.rsgbcc.org/hf
9	1300	9	1700	3.5, 7	Balkan HF Contest	CW Ph	RS(T), serial	hamyo.ro/balkanhf2019
9	1400	12	0800	1.8-144	Classic Exchange, Phone	Ph	Name, RS, SPC, radio manuf/model	www.classicexchange.org
10	0100	10	0259	3.5-14	CQC Winter QSO Party	CW	RST, SPC	www.coloradoqrpclub.org
10	0100	10	0300	1.8-28	4 States QRP Group Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	www.4sqrp.com
10	1300	14	2359	All (no WARC)	ARRL School Club Roundup	CW Ph	RS(T), Class (I/C/S), SPC	arrl.org/school-club-roundup
12	0130	12	0330	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
12	2000	12	2130	3.5	RSGB 80-Meter Club Championship, Data	Dig	RST, serial	www.rsgbcc.org/hf
14	0000	14	2359	1.8-7	PODXS 070 Club Valentine Sprint	Dig	Name, OM/YL, SPC	www.podxs070.com
15	0000	16	2359	1.8-28	ARRL International DX Contest, CW	CW	W/VE: RST + SP; non-W/VE: RST + power	www.arrl.org/arrl-dx
15	1200	16	1159	1.8-28	Russian PSK WW Contest	Dig	RST, 2-letter oblast or serial	www.rdrclub.ru
15	1900	15	2059	1.8-28	Feld Hell Sprint	Dig	RST, mbr, SPC, 4-char grid square	sites.google.com/site/feldhellclub
15	2300	16	2300	1.8-14	AWA Amplitude Modulation QSO Party	Ph	Name, SPC	www.antiquewireless.org
17	0200	17	0400	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, mbr or power	qrpcontest.com/pigrun
19	1900	19	2030	3.5	AGCW Semi-Automatic Key Evening	CW	RST, serial, year first used a bug	agcw.org/index.php/en
21	2200	23	2200	1.8	CQ 160-Meter Contest, SSB	Ph	W/VE: RS, SP; DX: RS, CQ Zone	cq160.com/rules.htm
22	0600	23	1800	3.5-28	REF Contest, SSB	Ph	RS, Department/Prefix or serial	concours.r-e-f.org/contest
22	1200	23	1200	3.5-28	UK/EI DX Contest, CW	CW	RST, serial, District code (if any)	www.ukeicc.com
23	1400	23	1700	3.5-14	SARL Digital Contest	Dig	RST, serial	www.sarl.org.za
23	1500	23	1700	3.5-28	High Speed Club CW Contest	CW	RST, mbr or "NM"	www.highspeedclub.org
24	1300	25	0400	1.8-28	QCX Challenge	CW	RST, name, SPC, rig	qrp-labs.com/party.html
26	0000	26	0200	1.8-28	SKCC Sprint	CW	RST, SPC, name, mbr or power	www.skccgroup.com
26	2000	26	2100	3.5	UKEICC 80-Meter Contest	CW	4-char grid square	www.ukeicc.com
27	2000	27	2130	3.5	RSGB 80-Meter Club Championship, CW	CW	RST, serial	www.rsgbcc.org/hf
29	1200	1	1159	1.8-28	Russian WW Multimode Contest	CW Ph Dig	RST(Q), oblast or serial	www.rdrclub.ru
29	1300	1	1300	3.5-28	UBA DX Contest, CW	CW	RST, serial, province (if ON)	uba.be/en/hf/contest-rules
29	1500	1	0159	1.8-50	South Carolina QSO Party	CW Ph Dig	RS(T), county or SPC	scqso.com
29	1800	1	0559	3.5-28	North American QSO Party, RTTY	Dig	Name, state/DC/province/country	www.ncjweb.com
29	1800	1	0559	3.5-28	NA Collegiate Championship, RTTY	Dig	Name, state/DC/province/country	www.w9smc.com/nacc

All dates refer to UTC and may be different from calendar dates in North America. Contests are not conducted on the 60-, 30-, 17-, or 12-meter bands. Mbr = Membership number. Serial = Sequential number of the contact. SPC = State, Province, DXCC Entity. XE = Mexican state. Listings in blue indicate contests sponsored by ARRL or *NCJ*. The latest time to make a valid contest QSO is the minute listed in the "Finish Time" column. *Data for Contest Corral is maintained on the WA7BNM Contest Calendar at* **www.contestcalendar.com** *and is extracted for publication in* QST *2 months prior to the month of the contest. ARRL gratefully acknowledges the support of Bruce Horn, WA7BNM, in providing this service.*

Jeff Wadsworth, KI5WL, ki5wl@arrl.net

2019 ARRL 10 GHz and Up Contest Results

Rus Healy, K2UA, and Dave Hallidy, K2DH, had perfect weather for the second weekend of the 2019 ARRL 10 GHz and Up contest. Just before sunset on Saturday, they operated from Hogback Mountain, Vermont, in grid square FN32. Pictured is their 24 GHz, 47 GHz, and 10 GHz equipment, pointed toward Martha's Vineyard, Massachusetts, and Block Island, Rhode Island. [Rus Healy, K2UA, photo]

This year's ARRL 10 GHz and Up Contest took place August 17 – 18 and September 21 – 22, 2019.

Logs Received by Call Area

Call Area	Entries
0	21
1	23
2	8
3	8
4	4
5	13
6	29
7	8
8	9
9	8
VE	13

Top Ten Scores

10 GHz Only		10 GHz and Up	
Call	Score	Call	Score
WØZQ	69,876	W6QIW	73,354
KA9VVQ	69,288	K6MG	64,408
W9FZ	69,047	K6ML	62,457
WBØLJC	64,320	N9JIM	61,532
AF1T	58,704	N6NU	46,293
W1MKY	57,395	K2DH	44,220
N5BF	54,430	N6TEB	40,720
K1RZ	49,115	VA3ELE	40,121
NØQJM	46,748	VA3TO	36,607
W7XU	46,748	K9PW	36,412

Best Terrestrial DX by Band

Call	Band	Distance (km)
VE3SMA/W1MKY/AF1T/K1RZ	10 GHz	719
K6MG/K6ML/W6QIW	24 GHz	343
KA1NKD/N1JEZ/W1FKF/W1GHZ	47 GHz	122
AA5AM/W5LUA	75 GHz	23

Full Results Online

You can read the full results of the contest online at **www.arrl.org/contest-results-articles** or **http://contests.arrl.org**. You'll find detailed analysis and more play-by-play, along with the full line scores. Improve your results by studying your log-checking report, too.

Call Area Leaders

10 GHz		10 GHz and Up	
Call	Score	Call	Score
Area 0			
WØZQ	69,876		
KA9VVQ	69,288		
W9FZ	69,047		
WBØLJC	64,320		
WA2VOI	49,173		
Area 1		**Area 1**	
AF1T	58,704	W1GHZ	36,065
W1MKY	57,395	W1FKF	24,908
N1JEZ	26,624	KA1NKD	24,908
W1AIM	24,361	K1OR	24,535
KB1VC	19,137	W1JHR	13,339
Area 2		**Area 2**	
KA2LIM	21,354	K2DH	44,220
N2MG	15,778	K2UA	33,528
N3RG	14,412		
W2FU	10,116		
WA2TMC	4,258		
Area 3			
K1RZ	49,115		
W2RMA	28,362		
W3SZ	16,774		
WA3PTV	8,922		
K2EZ	5,399		
Area 4			
N9ZL	9,472		
N4HB	4,286		
KØVXM	2,778		
W3IP	2,387		
Area 5		**Area 5**	
WQ5S	5,034	W5LUA	12,426
W5VY	2,600	AA5C	6,531
WA5TKU	2,302	AA5AM	4,018
K5LLL	1,872		
KI5WL	1,558		
Area 6		**Area 6**	
N5BF	54,430	W6QIW	73,354
N6VI	40,712	K6GZA	67,615
N6KLD	31,002	K6MG	64,408
AD7OI	24,491	K6ML	62,457
W6DL	21,699	N9JIM	61,532
Area 7			
N6RMJ	38,920		
KI7GVT	23,300		
N7GP	786		
W7GLF	472		
K7CVU	382		
Area 8		**Area 8**	
KB8U	23,766	K9JK	27,935
WW8M	7,290	WB8TGY	13,437
NN9X	6,782	KB8VAO	12,787
KD9GGZ	603	K2YAZ	12,748
		WA8VPD	11,131
Area 9		**Area 9**	
KA9VDU	13,470	K9PW	36,412
NØAKC	8,140	W9SZ	17,293
N9LB	5,689	KØKFC	17,075
KOØZ	1,524	AA9IL	12,423
Area 15 (Canada)		**Area 15 (Canada)**	
VE3KH	21,396	VA3ELE	40,121
VE3EG	14,407	VA3TO	36,607
VE3FN	12,694	VE3SMA	29,023
VE3JGL	8,586	VE2UG	15,240
VA3CDD	7,853		

Top Unique Call Leaders

10 GHz		10 GHz and Up	
Call	Unique Calls	Call	Unique Calls
AF1T	59	K2DH	56
W1MKY	58	W1GHZ	54
K1RZ	54	K2UA	46
KA2LIM	48	N6TEB	45
N1JEZ	47	VA3ELE	44
N6VI	46	W6QIW	44
W2RMA	43	K9PW	43
N5BF	42	VA3TO	43

Top Ten QSO Leaders

10 GHz

Call	Total QSOs
KA9VVQ	261
W9FZ	260
WBØLJC	258
WØZQ	257
N5BF	204
NØUK	187
KØHAC	183
AF1T	177
NØQJM	176
W7XU	176

10 GHz and Up

Call	Total QSOs
W6QIW	292
N9JIM	286
K6ML	280
K6MG	263
VA3ELE	213
N6NU	204
K9PW	200
VA3TO	198
N6TEB	170
K2DH	157

Best DX by Band in Kilometers

10 GHz		47 GHz	
Call	Best DX	Call	Best DX
VE3SMA	719	KA1NKD	122
W1MKY	719	N1JEZ	122
AF1T	719	W1FKF	122
K1RZ	719	W1GHZ	122
VE3KH	710	K9PW	106
W3SZ	709	VA3ELE	106
WW8M	709	KB8VAO	85
K1OR	697	WB8TGY	77
N4HB	697	AA9IL	41
KB8VAO	678	W5LUA	23
W2RMA	678	AA5AM	23

24 GHz		75 GHz	
Call	Best DX	Call	Best DX
K6MG	343	AA5AM	23
K6ML	343	W5LUA	23
W6QIW	343	KB8VAO	14
N6NU	272	WB8TGY	14
K2DH	254	WA8VPD	8
K1OR	254		
K2UA	254		
N9JIM	232		
W1GHZ	204		
N6TEB	193		

Helen Mahoney, KI6LQV, and Doug Millar, K6JEY, operated 24 GHz from atop Signal Hill, California, in grid square DM03. Helen contacted a station atop Frazier Mountain, a 133-kilometer path from their location near Long Beach. [Doug Millar, K6JEY, photo]

The next ARRL 10 GHz and Up Contest will be held August 15 – 16 and September 19 – 20, 2020.

John "JK" Kalenowsky, K9JK, k9jk@arrl.net

2019 ARRL 222 MHz and Up Distance Contest Results

This year's event was held August 3 – 4, 2019.

Regional Winners

Regions are defined in the contest rules (**www.arrl.org/222-mhz-and-up-distance-contest**). Category key: R — Rover; SOF — Single Operator, Fixed, and MOF — Multioperator, Fixed.

Region	Category	Call	Score
1	R	KE7MSU/R	5,437
	SOF	VE7FYC	8,326
	MOF	K3RW	1,016
2		No Entries	
3	R	N6ZE/R	2,775
	SOF	KC6ZWT	9,088
4	SOF	W9RM	12,566
5	SOF	WB2FKO	4,716
	MOF	KC5MVZ	22
6	R	WØZF/R	18,740
	SOF	WBØULX	135
7	SOF	KØTPP	12,070
8	SOF	W5LUA	10,728
9	R	W9SNR/R	9,325
	SOF	K9YR	3,301
10	R	NØHJZ/R	6,539
	SOF	WØUC	28,618
	MOF	WØVTT	32,442
11	R	KF2MR/R	58,251
	SOF	VE3ZV	51,619
	MOF	N2SLN	30,965
12	R	AG4V/R	13,299
	SOF	N4QWZ	15,096
13	R	K4SME/R	12,660
	SOF	KØVXM	89,408
14	SOF	K1RZ	102,579
15	R	NN3Q/R	52,570
	SOF	N3RG	93,818
16	R	W1RGA/R	13,593
	SOF	K1TEO	214,625
17		No Entries	
18	SOF	AL7JX	147

Teams

Name	Score	Region
Large		
Packrats	354,047	15
Lake Ontario Group	242,799	11
UHF Da!	77,656	10
Going the Distance	18,549	9
Small		
Really Weak Signal Group	377,142	16
Alpha Hotel	116,817	13
Glacial Sideband	19,106	6
CVVHF'ers	18,552	10

The next ARRL 222 MHz and Up Distance Contest will be held August 1 – 2, 2020.

Full Results Online

You can read the full results of the contest online at **www.arrl.org/contest-results-articles**. You'll find detailed analysis and more play-by-play, along with the full line scores. Improve your results by studying your log-checking report, too.

Tom Tumino, N2YTF, and Tom Zajdel, AI6CU, hiked to the summit of New York's Hook Mountain, overlooking the Hudson River in grid square FN31. They operated on the 23- and 33-centimeter bands during the 2019 ARRL 222 MHz and Up contest.

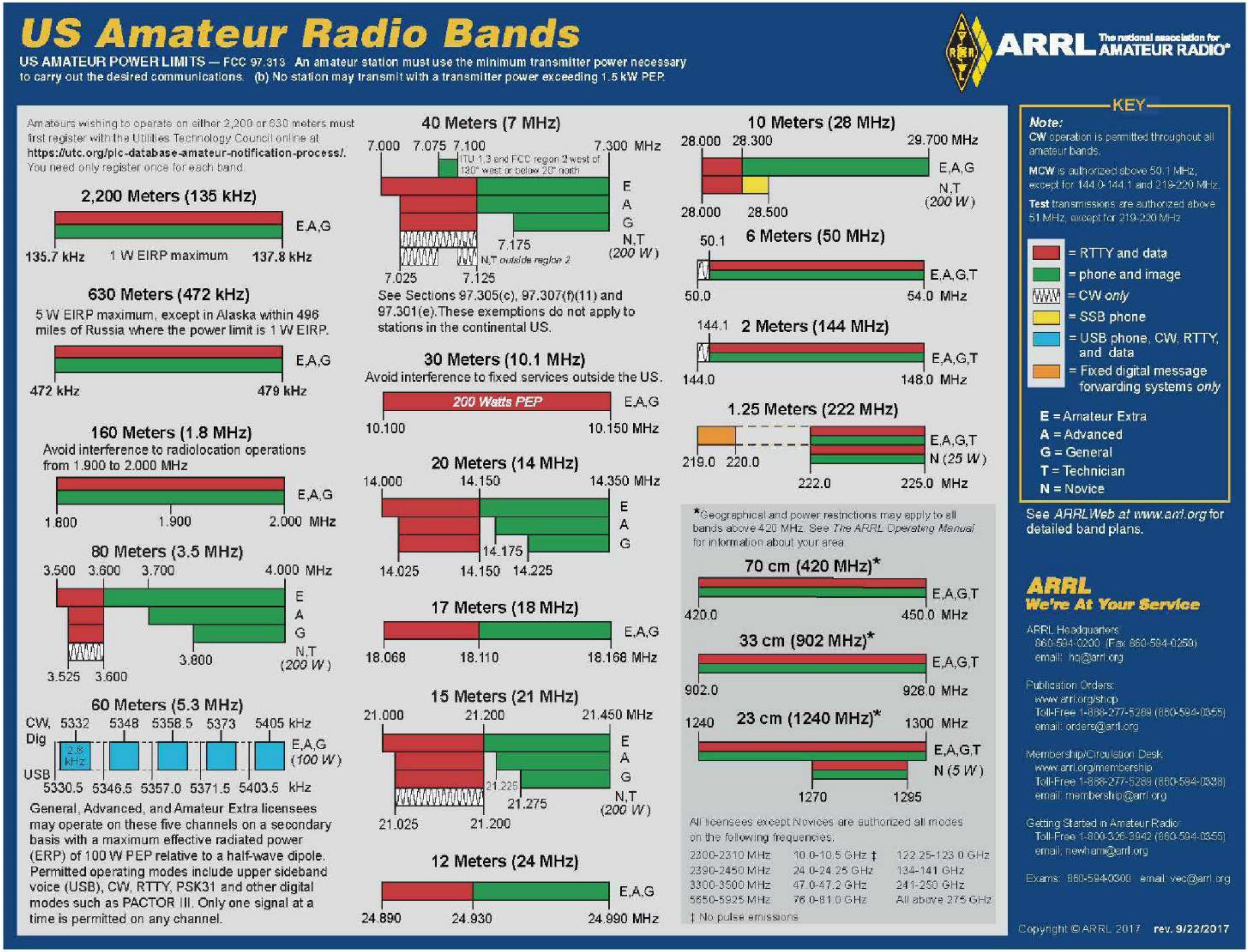
Affiliated Club Competition

Club	Score	Entries
Medium		
Mt. Airy VHF Radio Club	545,312	17
Rochester VHF Group	246,443	10
North East Weak Signal Group	219,298	11
Florida Weak Signal Society	200,174	8
Northern Lights Radio Society	92,554	10
Badger Contesters	41,009	7
Pacific Northwest VHF Society	38,513	13
Michigan VHF-UHF Society	25,532	3
Society of Midwest Contesters	7,767	3
Local		
Chippewa Valley VHF Contesters	18,573	4

Strays

QST Congratulates…

ARRL Ohio Section Manager Scott Yonally, N8SY, on receiving the Southern Ohio Amateur Radio Association's (SOARA) special recognition award "Above and Beyond" for his outstanding contributions to ARRL, the Ohio Section, and the Southern Ohio Amateur Radio Association. Michael Love, WB8YKS, made the presentation at the SOARA "Christmas in November" dinner in November 2019.



US Amateur Radio Bands
US AMATEUR POWER LIMITS — FCC 97.313 An amateur station must use the minimum transmitter power necessary to carry out the desired communications. (b) No station may transmit with a transmitter power exceeding 1.5 kW PEP.
ARRL The national association for AMATEUR RADIO®
Amateurs wishing to operate on either 2,200 or 630 meters must first register with the Utilities Technology Council online at https://utc.org/plc-database-amateur-notification-process/. You need only register once for each band.
2,200 Meters (135 kHz)
E,A,G
135.7 kHz
1 W EIRP maximum
137.8 kHz
630 Meters (472 kHz)
5 W EIRP maximum, except in Alaska within 496 miles of Russia where the power limit is 1 W EIRP.
E,A,G
472 kHz
479 kHz
160 Meters (1.8 MHz)
Avoid interference to radiolocation operations from 1.900 to 2.000 MHz
E,A,G
1.800
1.900
2.000 MHz
80 Meters (3.5 MHz)
3.500 3.600 3.700
4.000 MHz
E
A
G
N,T (200 W)
3.525 3.600
3.800
60 Meters (5.3 MHz)
CW, Dig
5332 5348 5358.5 5373 5405 kHz
2.8 kHz
E,A,G (100 W)
USB
5330.5 5346.5 5357.0 5371.5 5403.5 kHz
General, Advanced, and Amateur Extra licensees may operate on these five channels on a secondary basis with a maximum effective radiated power (ERP) of 100 W PEP relative to a half-wave dipole. Permitted operating modes include upper sideband voice (USB), CW, RTTY, PSK31 and other digital modes such as PACTOR III. Only one signal at a time is permitted on any channel.
40 Meters (7 MHz)
7.000 7.075 7.100
7.300 MHz
ITU 1,3 and FCC region 2 west of 130° west or below 20° north
E
A
G
N,T (200 W)
7.175
N,T outside region 2
7.025 7.125
See Sections 97.305(c), 97.307(f)(11) and 97.301(e). These exemptions do not apply to stations in the continental US.
30 Meters (10.1 MHz)
Avoid interference to fixed services outside the US.
200 Watts PEP
E,A,G
10.100
10.150 MHz
20 Meters (14 MHz)
14.000 14.150
14.350 MHz
E
A
G
14.175
14.025 14.150 14.225
17 Meters (18 MHz)
E,A,G
18.068 18.110
18.168 MHz
15 Meters (21 MHz)
21.000 21.200
21.450 MHz
E
A
G
N,T (200 W)
21.225
21.275
21.025 21.200
12 Meters (24 MHz)
E,A,G
24.890 24.930
24.990 MHz
10 Meters (28 MHz)
28.000 28.300
29.700 MHz
E,A,G
N,T (200 W)
28.000 28.500
6 Meters (50 MHz)
50.1
E,A,G,T
50.0
54.0 MHz
2 Meters (144 MHz)
144.1
E,A,G,T
144.0
148.0 MHz
1.25 Meters (222 MHz)
E,A,G,T
N (25 W)
219.0 220.0
222.0
225.0 MHz
*Geographical and power restrictions may apply to all bands above 420 MHz. See The ARRL Operating Manual for information about your area.
70 cm (420 MHz)*
E,A,G,T
420.0
450.0 MHz
33 cm (902 MHz)*
E,A,G,T
902.0
928.0 MHz
23 cm (1240 MHz)*
1240
1300 MHz
E,A,G,T
N (5 W)
1270 1295
All licensees except Novices are authorized all modes on the following frequencies:
2300-2310 MHz 10.0-10.5 GHz ‡ 122.25-123.0 GHz
2390-2450 MHz 24.0-24.25 GHz 134-141 GHz
3300-3500 MHz 47.0-47.2 GHz 241-250 GHz
5650-5925 MHz 76.0-81.0 GHz All above 275 GHz
‡ No pulse emissions
KEY
Note:
CW operation is permitted throughout all amateur bands.
MCW is authorized above 50.1 MHz, except for 144.0-144.1 and 219-220 MHz.
Test transmissions are authorized above 51 MHz, except for 219-220 MHz
= RTTY and data
= phone and image
= CW only
= SSB phone
= USB phone, CW, RTTY, and data
= Fixed digital message forwarding systems only
E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice
See ARRLWeb at www.arrl.org for detailed band plans.
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Bernie McClenny, W3UR, w3ur@arrl.org

South Orkney Islands Update

The June 2019 "How's DX?" column provided details of the anticipated Perseverance DX Group's imminent DXpedition to Signy Island in the South Orkney Islands of Antarctica. This one ranks number 16 on Club Log's Most Wanted List and is on the DX calendar for February 21 to March 5. Since the original details from last summer, a few things have changed. Here are some updates.

Sponsors

The Northern California DX Foundation (**www.ncdxf.org**) has donated $30,000 to help with the team's $325,000 budget. Additional foundation donors include the Germany DX Foundation, Far East DX-Ploiters, and the Clipperton DX Club. The team was also awarded the Colvin Award, administered by ARRL. Elecraft has jumped on board as a sponsor, loaning the team K3s, KPA500s, and P3s. DX Engineering, Arlan Communications (RadioSport), and RigExpert have also pitched in.

Team Call Sign

They will be using the call sign VP8/VP8DXU. It's an odd situation now that Falkland Islands seems to no longer issue call signs to the islands of South Georgia, South Sandwich, South Shetlands, and South Orkney. Team member Arliss, W7XU, has the call VP8DXU, which was issued for operations from the Falklands. The team will add VP8 to the beginning of that call sign, because it is also a prefix that can be used from the South Orkney Islands. They could have used any of the team members' own personal call signs followed by the VP8 prefix but thought this best for DXers.

During the second week of July, the VP8/VP8DXU team gathered to assemble their three tents. They made repairs, constructed and "kit" the bases/floorings, then repacked for the trip to Signy. These were the same tents used on the 2011 South Orkney VP8ORK DXpedition and the July 2018 KH1/KH7Z DXpedition on Baker Island. They also met in October to pack the rest of the team's equipment and antennas.

Table 1
South Orkney Target Transmit Frequencies

CW	SSB	RTTY	FT8
1.826.5	—	—	1.840
3.523	3.790	—	3.567
—	—	—	5.357
7.010	7.090	7.045	7.056
10.105	—	10.142	10.131
14.023	14.185	14.080	14.090
18.069	18.130	18.100	18.095
21.023	21.285	21.080	21.091
24.891	24.955	24.910	24.911

VP8/VP8DXU Operators

Since the original announcement, there have been a few operator changes. As of press time, the current list of operators includes Expedition Leader Dave, K3EL; Co-Team Leader Les, W2LK; Co-Organizer and Treasurer Gene, K5GS; Medical Officer Dr. Arliss, W7XU/VP8DXU; and expedition team members Heye, DJ9RR; Laci, HAØNAR; Vadym, UT6UD; Walt, N6XG; Rob, N7QT; Steve, W1SRD; Mike, WA6O; Ken, NG2H, and Hans-Peter, HB9BXE.

Pilot Stations

The pilot stations for this DXpedition (those who communicate with the on-island team and relay news back to the DX community) will be North American Chief Pilot Glenn, KE4KY; North American Assistant Pilot Mason, KM4SII; European Pilot Björn, ON9CFG; European and Russian-Speaking Pilot Alex, 4L5A; Japanese Pilot Hiroo, JA1WSX; South American Pilot Cesar, PY2YP; Oceania Pilot Luke, VK3HJ, and African Pilot Andre, V51B.

Frequencies

The VP8/VP8DXU team will be operating split frequency, meaning they will transmit on one frequency and be listening for callers (DXers) on a separate frequency or frequency range. Listen carefully to their requests. A list of their target transmit frequencies can be found in Table 1. Most likely they will say, "I am listening up 5 to 15 KHz," or on CW they may send, "QSX up 5." Please do not transmit on VP8/VP8DXU's transmit frequency, as you will no doubt upset many of your competitors who are likewise trying to work the DX station. The team has prepared a web page with some helpful tips as to how to work this DXpedition at **www.sorkney.com/how-to-work-us/**.

DX News From Around the Globe

5H – Tanzania

The Italian DX Team (IDXT) will be operating from Zanzibar Island (AF-032) using the unique call signs 5I5TT and 5I4ZZ from February 4 – 18. The team ensures high-quality operating and instant online logging.

The IDXT will use 5I5TT on CW, SSB, and RTTY, and while on FT8 they will use the separate 5I4ZZ call sign. As always, you can count on them to be active on 1.8 through 28 MHz. The team includes veteran DXpeditioners I2YSB, I1HJT, I2PJA, IK2CIO, IK2CKR, IK2DIA, IK2HKT, IW1ARB, and JA3USA. They plan to have four stations operating around the clock throughout the DXpedition. You can keep up with the latest news on this DXpedition by watching your favorite DX outlet and their website at **www.i2ysb.com/idt/**.

E4 – Palestine

Another DXpedition team will be starting their operation during the first full week of February as members of the Radio Club de Provins (F6KOP) and have announced their plans to activate E44CC. This is the team that brought us 9LY1JM in 2018 and many other DXpeditions over the years. They will be operating from Bethlehem in the West Bank from February 5 – 17. Plans are to be on 1.8 through 28 MHz on CW, SSB, RTTY, PSK, FT4, and FT8. This one will be led by Frank, F4AJQ; Co-Leader Jean-Luc, F1ULQ; Patrick, F2DX; Damien, F4AZF; Jimi, F4DLM; Wil, F4ESV; Thierry, F4TTR; Raymond, F5MFV; Maurice, F5NQL; Stephane, F5UOW; Julien, F8AVK; Andreas, DL3GA; Herman, ON4QX; Eric, ON7RN, and Ken, OZ1IKY. These are all the details as of press time. Keep an eye on their website at **www.palestine2020.wordpress.com**.

YS – El Salvador

German operators DH8WR, DJ6TF, DJ9KH, DL1KWK, DL2HWA, DL2RNS, DL4SVA, DL7JOM, DL7VEE, and DL9GFB have announced their plans for a "lightweight adventure" to the Pacific Coast of El Salvador, where they will be operating with special call **HU1DL** from January 30 to February 13. This operation is thanks to the support of Salvadoran operators YS1GMV, YS1AG, YS1MAE, YS1RS, YS1MS, and the 2012 HU2DXpedition team. The 10 experienced DXpeditioners will have three stations running kilowatt power around the clock. Listen for HU1DL to be operating on 17 through 160 meters on CW, SSB, RTTY, and FT8. This will include 60 meters, and they will also try 6 meters. QSL via DL2SVA, Logbook of The World (LoTW), and OQRS. Check for updates on the HU1DL website at **https://hu1dl.mydx.de**.

Wrap-Up

That's all for this month, with special thanks to DL7VEE, K5GS, and the IDXT. Don't forget to send your DX, Islands on the Air (IOTA), or contest news to **bernie@dailydx.com**. Until next month, see you in the pileups!
— *Bernie, W3UR*

Strays

QST Congratulates…

Cliff Kayhart, W4KKP. At age 108, he is America's oldest known ham radio operator and was the recent recipient of ARRL's Centurion Award, which recognizes ARRL members over the age of 100. At the November meeting of the Dutch Fork Amateur Radio Group in Little Mountain, South Carolina, Roanoke Division Director Bud Hippisley, W2RU; Vice Director Bill Morine, N2COP, and South Carolina Section Manager Marc Tarplee, N4UFP, presented Cliff with the award.

Born in October 1911, Cliff first became licensed as W2LFE in 1937, and then held the call sign W9GNQ before becoming W4KKP. He served in Iwo Jima in World War II, setting up long-range radio communications from the island to Tokyo to arrange for the eventual surrender by the Japanese. He is still active on the air, checking into several nets from his assisted living facility. Centurion Award recipients have their annual ARRL membership fees waived while continuing to receive *QST* and other ARRL member benefits.

From left to right: Roanoke Division Director Bud Hippisley, W2RU; Cliff Kayhart, W4KKP; Roanoke Division Vice Director Bill Morine, N2COP, and South Carolina Section Manager Marc Tarplee, N4UFP.

Cliff Kayhart was profiled in "Member Spotlight," in the June 2018 issue of *QST*.

Jon Jones, NØJK, n0jk@arrl.org

222 MHz Radios

For many people who want to get on the 1.25-meter band, the biggest challenge is buying a radio. Unlike the other low VHF and UHF bands where there are many radios that cover 50, 144, and 432 MHz, there are few commercial offerings for 222 MHz — particularly for SSB and CW. Larry, NØLL, uses both the Yaesu FT-736R and Icom-375A on 222 MHz. They are older but effective radios. Larry says to use the Icom-375A on digital modes. He had to buy a custom cable from Associated Radio to access the ACC Port 1 for data. Rick, WØRT, said:

> I recommend the Yaesu FT-736R. They are generally available on **QTH.com**, eBay, and at hamfests. People will try to scalp you on the 222 MHz modules for the FT-736. Many are asking for $500. I was patient and recently bought one for my second FT-736 for $250. Other than that, the transverter route is the way to go.

I use the Han Peter microwave modules for 28 – 220 (222) MHz transverter. It is 1980s technology, but still works fine. SSB Electronics offers a state-of-the-art 222 MHz transverter — the TR222H. At 25 W output, one can make many contacts at this level or use it to drive an amplifier. Down East Microwave has the L222-8 transverter and 222PA amplifier at 1.5 kW. For the DIY enthusiast, the Ukraine "transverters store" has an inexpensive 28/222 MHz board (see Figure 1). It puts 8 – 10 W out. Some people have had good results with this product. Doug, WA7XX, is "now running a Q5 transverter driving a Harris channel 11 amp at a kilowatt." He and others have noted some stability issues with the Ukranian transverters for digital meteor scatter. *WSJT-X* MSK144 and FSK441 require high-frequency stability to work properly.

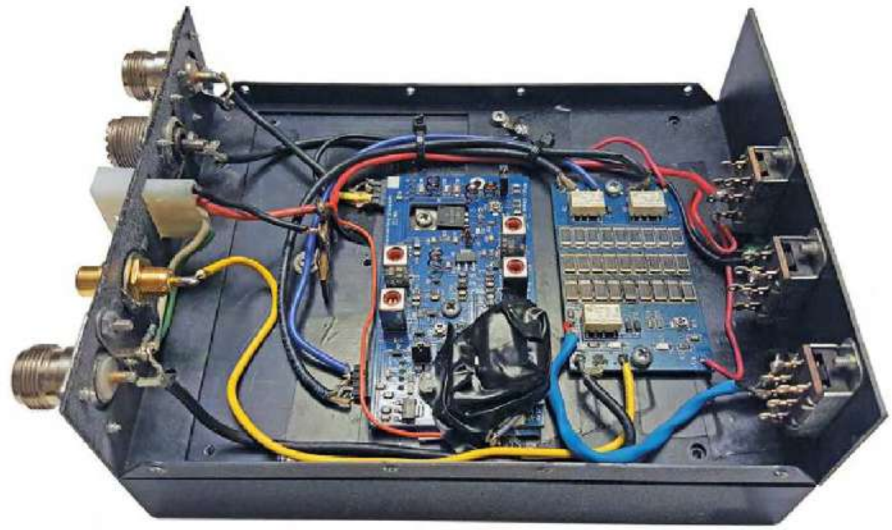


Figure 1 — Doug, WA7XX, uses a 222 MHz transverter he put together. The board is one of the Ukraine 222 MHz transverters. [Doug Gilliam, WA7XX, photo]

Paul, W1GHZ, published an article in the January 2017 issue of *QST* on adding a 222 MHz transverter to the FT-817 that could also be useful.

John Lock, KFØM, said, "My 222 MHz station is a TEN-TEC 525 driving a Hans Peters MMT-222 transverter and a Mirage 80 W brick amplifier with J-FET preamp." John noted the old surplus FAA amplifiers, such as the AM-6155, were an inexpensive way to get to almost 300 W on 222 MHz. The conversion to 222 MHz is straightforward. N1RWY has resources for converting these amplifiers to 222 MHz at **www.n1rwy.org/am6155/mods.html**.

Both John and I used the AM-6155 on 220, then 222 MHz.

The "Unicorn" Meteor Shower

There was an outburst of Alpha Monocerotid meteors on November 22. As predicted by forecasters Esko Lyytinen and Peter Jenniskens (NASA/Ames), Earth grazed a filament of comet dust, prompting a flurry of meteors to emerge from the constellation Monoceros (the Unicorn). Rich, K1HTV, observed:

> 50 MHz came to life for a brief period on Friday, November 22, when a short outburst of the Alpha Monocerotid meteor shower occurred. The shower had been predicted to start at 0415 UTC with a short, intense, burst predicted at 0450Z. This shower had previous outbursts in 1925, 1935, 1985, and 1995. Well, the predictors pretty much nailed it. The Virgo software indicated the optimum path to be SSW to SSW. I started to hear a number of MSK144 signals on 50.260 MHz just before 0500Z.

Larry, NØLL (EM09), found:

> There was a little dust from the Alpha Monocerotids last night. That map on **spaceweather.com** seemed to be very accurate. The farther east one was, the better the outburst. Here, the meteors had to be just dust. All 6-meter MSK144

Figure 2 — Charlie's, NØAKC, 222 MHz EME array with two 222 MHz Yagis outside the inner four 70-centimeter Yagis. He has worked N9HF in Florida and K7ULS in Utah via EME with this antenna. [Charlie Betz, NØAKC, photo]

> contacts took place here. The first one was at 0241 with KE8FE (EM64). He was in a lot. At 0503Z, I worked W4IMD (EM84), then W5THT (EM50) at 0513Z, AB4EJ (EM63) at 0517Z, and lastly, I made a contact with N9LYE (EN51) 0554Z.

N2AMC (FN30) worked KE4KOL (EM78) on 2-meter MSK144 at the shower peak. The Unicorn Shower favored stations in the eastern half of North America. But some stations along the west coast noted enhanced conditions as well. Paul, K7CW, noted, "I showed up late, but I worked some stations in W6, W7OJT in Arizona, and WY7FD in Wyoming. I started to work stations at 0541Z and got the last contact at 0554Z."

Tom, K8TB, in EN72 near Grand Rapids, Michigan, "worked maybe 20 stations. I had a sporadic-E path to K1SIX (FN43) in New Hampshire, but most of my contacts were true meteor scatter."

Pete Heins, N6ZE, made a nice summary of the shower results. Pete offered congratulations to Lyytinen and Jenniskens for successfully predicting the Alpha Monocerotids outburst. "They nailed the timing of the encounter. Earth passed by the filament of dust around 0500Z, within 10 minutes of the forecast." The intensity of the outburst was less than they expected by a factor of perhaps 5. "That could mean we crossed the dust trail further away from the parent comet than we expected, suggesting that the comet is moving away from us," noted Jenniskens.

Amateur radio made a significant contribution to meteor shower astronomy by confirming the outburst time prediction and showing possible movement of the filament away from the Earth.

On the Bands

50 MHz. WA2GFN found some E_s in the morning to W4 on November 9. On November 10, Danny, KB8W (EN57), had strong E_s to Texas and Oklahoma over short 800-kilometer paths. He runs 50 W to a five-element Yagi up 20 feet. On November 19, Mario, K2ZD, worked 5H3EME on JT65 EME for his 210th DXCC contact. Signals were –27 dB.

144 MHz. On November 6, Larry, NØLL (EM09), worked expedition KE7NR/P (DM54) via MSK144, with signals peaking at 15 dB. On November 26, Mike, K7ULS, in Utah, logged W5TRL (EM10) at 1324Z with MSK144. Mike had "huge rocks" while working W5LDA (EM15) at 1449Z on MSK144 (see Figure 2). K7ULS runs 130 W to a single M2-2M18XXX Yagi.

222 MHz. Doug, WA7XX (DM42), logged K7KQA (DN06) using FSK441 on November 2. Larry, NØLL (EM09), worked W9RM (DM58) on MSK144 on November 18. Charlie, NØAKC, worked VE6TA on JT65 EME also on the 18th (see Figure 2). On November 19, K7ULS logged VE6TA on JT65 EME. K7ULS noted when he worked K1OR via EME in August 2019, it was a single Yagi to a single Yagi on EME.

Here and There

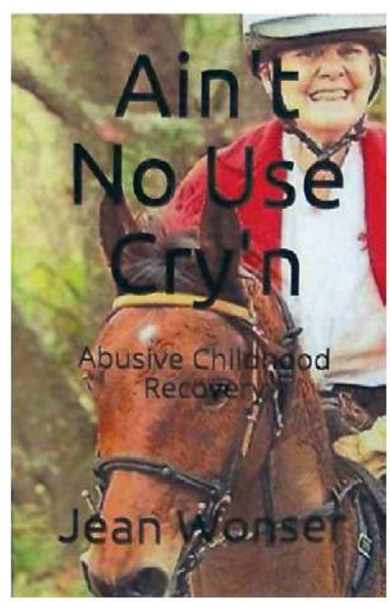
Steve Kostro, N2CEI, of Down East Microwave, just announced a new five-band transverter covering 2 meters through 23 centimeters. For more information, visit **www.downeastmicrowave.com/product-p/vuxvert.htm**.

Steve had a prototype model on display at last year's Central States Conference. Power output is about 1 W, and he said the price will be in the $500 range. — *Courtesy of Charlie, NØAKC.*

Strays

QST Congratulates...

Jean Wonser, N4JHW, on the publication of her memoir *Ain't No Use Cry'n*. The author tells of her journey as a survivor of child abuse with the help of her horses, family, and role models. She describes her experiences in teaching, as well as years spent as a correctional officer. The book is available on **Amazon.com**.



Special Event Stations

Working special event stations is an enjoyable way to help commemorate history. Many provide a special QSL card or certificate!

Jan. 18, 1600Z – 2100Z, K7T, Tucson, AZ. Oro Valley Amateur Radio Club. **Madera Canyon — Birding Capital of Arizona**. 14.250 14.040 7.200; FT-8 18.100. Certificate. Email **qsl@tucsonhamradio.org** for certificate. *No paper QSLs please.* **www.tucsonhamradio.org**

Jan. 25, 1600Z – 2100Z, KSØKS, Edgerton, KS. Santa Fe Trail Amateur Radio Club. **Kansas Day**. 14.250 14.055 10.115 7.250. QSL. SFTARC, P.O. Box 3144, Olathe, KS 66063. **www.sftarc.org**

Feb. 1, 1400Z – 2100Z, K3HWJ, Punxsutawney, PA. Punxsutawney Amateur Radio Club. **Groundhog Day Special Event Station**. 14.330 7.235. Certificate. Stephen Waltman, KB3FPN, 37 Clark St., Brookville, PA 15825. **punxyclub.com**

Feb. 1 – Feb. 2, 1500Z – 2300Z, K5C, Nacogdoches, TX. Nacogdoches Amateur Radio Club. **Shuttle *Columbia* Special Event**. 14.260 14.174 7.220 7.174. QSL. Nacogdoches Amateur Radio Club, 167 County Rd. 2093, Nacogdoches, TX 75965. *All contacts will be confirmed via LoTW.* **www.w5nac.com**

Feb. 1 – Feb. 29, 0000Z – 2359Z, N9SES, Lake Station, IN. Arab QRZ Club. **JY1 Special Event Memorial Station 2020**. 3.25 – 3.50, 7.025 – 7.050, 10.103 – 10.110, 14.252. QSL. Ayman Azar, 2861 Decatur St., Lake Station, IN 46405. **www.n9ses.com/?page_id=18**

Feb. 8, 1600Z – 2300Z, N4SCV, Gainesville, FL. Sons of Confederate Veterans Camp 1424. **Lee/Jackson**. 14.240 7.224. QSL. Madison Starke Perry Camp 1424, P.O. Box 998, Alachua, FL 32616. **https://www.gatorscv.com/events**

Feb. 8, 1700Z – 2359Z, NI6IW, San Diego, CA. USS *Midway* (CV-41) Museum Ship. **Mount Suribachi Flag Raising**. 14.320 7.250 PSK31 14.070 DSTAR REF001C. QSL. USS *Midway* Museum Ship COMEDTRA, 910 N. Harbor Dr. San Diego, CA 92101.

Feb. 12 – Feb. 16, 0000Z – 2359Z, N4DAB, Daytona Beach, FL. Daytona Beach CERT Amateur Radio Team. **2020 Daytona 500**. 14.255 14.076 7.255 7.076. Certificate & QSL. Steve Szabo, 536 Central Park Blvd., Port Orange, FL 32127-1136. **www.n4dab.com**

Feb. 15, 1400Z – 2000Z, W1M, Russell, MA. Western Mass Council Scouting USA. **WHOA/SCOTA**. 14.290 14.060 7.190 7.060. QSL. Tom Barker, 329 Faraway Rd., Whitefield, NH 03598. *Paper logging is used; there will be a delay in sending out QSL cards.*

Feb. 15, 1400Z – 2200Z, WØEBB, Leavenworth, KS. Kickapoo QRP Amateur Radio Club. **16th Annual *Freeze Your Keys* Winter Operating Event**. CW: 14.058 7.035; SSB 14.325 7.240. QSL. Gary Auchard, 34058 167th St., Leavenworth, KS 66048. **w0mna74@gmail.com**

Feb. 15, 1600Z – 2100Z, W5BMC, Morgan City, LA. Bayouland Emergency Amateur Radio Society BEARS. **15th Annual Eagle Expo**. 14.260 7.260. QSL. Jackie Price, 708 Front St., Morgan City, LA 70380.

Feb. 15 – Feb. 17, 1600Z – 2300Z, WØJH, Stillwater, MN. Stillwater Amateur Radio Association. **Ice Station WØJH (Frozen Lake Portable)**. 21.360 14.260 7.260 3.860. Certificate. Shel Mann, NØDRX at **icestation2020@radioham.org**. Grid Square EN34. *The club's youth are planning to independently operate throughout the event. Certificates will only be sent via email, as PDFs.* **www.radioham.org**

Feb. 15 – Feb. 16, 1500Z – 1700Z, K4US, Alexandria, VA. Mt. Vernon Amateur Radio Club. **George Washington's Birthday**. 14.260 14.074 7.040. Certificate. MVARC, P.O. Box 7234, Alexandria, VA 22308. **www.mvarc.org**

Feb. 17, 1400Z – 2100Z, N4HLH, Charleston, SC. Trident Amateur Radio Club. **SES *H. L. Hunley* Commemorative Station**. 14.262 7.262 7.117. QSL. Larry Gatton, P.O. Box 60732, Charleston, SC 29416. **tridenthams.org/hunley.htm**

Feb. 21 – Feb. 23, 2359Z – 2359Z, WS7G, Moses Lake, WA. Columbia Basin DX Club. **George Washington's Birthday**. 14.255 7.222 3.855. QSL. Brian Nielson, 11650 Road 1 SE, Moses Lake, WA 98837. **cbn.homestead.com/WS7G.html**

Feb. 22, 1600Z – 2100Z, K7T, Tucson, AZ. Oro Valley Amateur Radio Club. **Titan Missile Museum**. CW 14.040 7.040; SSB 14.250; FT8 18.100. Certificate. Email **qsl@tucsonhamradio.org**. *No paper QSLs please.* **www.tucsonhamradio.org**

Feb. 26, 1500Z – 2100Z, W7ASL, Mesa, AZ. Sunlife Amateur Radio Club. **Snowbird Field Day**. 14.230 7.200. QSL. Tom Goforth, 4324 E. Dragoon Cir., Mesa, AZ 85206. *Please see the website for the most up to date information.* **www.sunlifearc.org/index.php/events/2-uncategorised/28-snowbird-field-day**

Certificates and QSL cards: To obtain a certificate from any of the special event stations offering them, send your QSO information along with a 9 × 12-inch self-addressed, stamped envelope (three units of postage) to the address listed in the announcement. To receive a special event QSL card (when offered), be sure to include a self-addressed, stamped business envelope along with your QSL card and QSO information. *Note: Some clubs may ask for a nominal fee to cover the cost of the certificate or QSL. Request will be made on air during the event or on the club's website.

Special Events Announcements: For items to be listed in this column, use the ARRL Special Events Listing Form at **www.arrl.org/special-events-application**. A plain-text version of the form is available at that site. You may also request a copy by mail or email. Off-line completed forms can be mailed, faxed (Attn: Special Events), or emailed.

Submissions must be received by ARRL HQ no later than the 1st of the second month preceding the publication date; a special event listing for **April** *QST* would have to be received by **February 1**. In addition to being listed in *QST*, your event will be listed on the ARRL Web Special Events page. Note: All received events are acknowledged. If you do not receive an acknowledgement within a few days, please contact us. ARRL reserves the right to exclude events of a commercial or political nature.

You can view all received Special Events at **www.arrl.org/special-event-stations**.

Certificate of Code Proficiency

Recipients

Sponsored by VIBROPLEX
www.vibroplex.com

This month, ARRL and Vibroplex recognize merit and progress in Morse code proficiency on the part of the following individuals, who have achieved proficiency at the following rates, in words per minute.

September 2019

Howard D. Campbell, NØKOE	10
Wayne Chapman, KG5WU	10
Martin R. Griek, KØMRG	10
Eddie R. Lary, WS4I	10
Marcus R. Singh, ACØBZ	10
William B. Dick, WD6EGW	15
Robert E. Gardner, Jr., WA8PCW	15
Stanley Alan Sines, W3AL	15
Lloyd G. Gipson, AKØRK	20
Roy E. Gothberg, W7HJL	20
Robert Alan Griffiths, NE3I	20
Brian K. Moore, KM6ZYC	20
David W. Wilkins, WØPF	20
Daniel J. Sands, Sr., N7SU	25
Earl D. Wilson, Jr., K6GPB	25
William J. Wrbican, K3QP	25
Stephen R. Gross, N4PZ	35
Michael E. Kelly, VE3FFK	35

October 2019

Dennis J. Niles, WV7S	10
James A. Standish, K4TUW	10
Russell W. Tine, K1RWT	10
Geo. Wayne Moore, W8SUN	15
Donald J. Backys, K9UQN	20

November 2019

David A. Bamford, W2DAB	10
Michael J. Erskine, W4MHZ	10
Mark G. Feuerstein, N7MMO	10
John F. Johnson, N8JFJ	10
Michael W. Geoghegan, KX6A	10
Donald E. Kirby, KR3A	10
William A. Miller, W6QA	10
James D. Russ, AB4KA	10
Warren T. Seeley, W4FLL	10
Stephen P. White, KL3MM	10
David J. Wise, KD6EOD	10
Frank P. Arciuolo, W1ZAH	15
Keith Austermiller, KB9STR	15
Michael J. Erskine, W4MHZ	15
Paul W. Peterson, K1HIS	15
John F. Wasciuk, WA8TON	15
Stephen M. Zappe, WA3GQA	15
Joe P. Bratton, AA5AD	20
Raymond T. Henderson, WA3PRR	20
Michael Terry Jones, W4TL	20
Roy S. Ludwig, KN4WOJ	20
Stephen J. Mlecik, K1NA	20
Akihiro Akai, JQ2UOZ	25
Donald J. Backys, K9UQN	25
Michael Terry Jones, W4TL	25

December 2019

James T. Griffin, N4JG	10
Martin Hickey, AJ6CL	10
Steve M. Kuzyszyn, KB2WQ	10
Steven G. Fein, KM6VOV	15
Stanford H. Rowe, K6VWE	15
David J. O'Farrell, WBØIXV	20

Congratulations to all the recipients.

February 2020 W1AW Qualifying Runs

W1AW, the Hiram Percy Maxim Memorial Station at ARRL Headquarters in Newington, Connecticut, transmits Morse code Qualifying Runs to assist ham radio operators in increasing and perfecting their proficiency in Morse code. Amateur radio operators can earn a Certificate of Code Proficiency or endorsements by listening to W1AW Qualifying Runs.

February Qualifying Runs will be transmitted by W1AW in Newington, Connecticut at the times shown at 1.802.5, 3.581.5, 7.047.5, 14.047.5, 18.097.5, 21.067.5, 28.067.5, 50.350, and 147.555 MHz. The West Coast Qualifying Runs will be transmitted by KH6TU on Wednesday, February 26 at 6 PM HST (0400 UTC February 27) on 7047.5 and 14047.5 kHz. Unless indicated otherwise, sending speeds are from 10 to 40 WPM.

Amateur radio operators who participate in Qualifying Runs may submit proof of 1 minute of the highest speed they have copied in the hope of qualifying for the Certificate of Code Proficiency, or an endorsement to their existing Certificate.

Legibly copy at least 1 minute of text by hand, and mail the sheet to: W1AW Qualifying Runs, 225 Main St., Newington, CT USA 06111.

Include $10 (check or money order) if this is a submission for your initial Code Proficiency certificate; $7.50 if you are applying for an endorsement (available for speeds up to 40 WPM). Your test will be checked against the actual transmissions to determine if you have qualified.

For more information about Qualifying Runs, please visit **www.arrl.org/qualifying-run-schedule**.

For information about how to qualify for the Certificate of Code Proficiency, please visit **www.arrl.org/code-proficiency-certificate.**

W1AW Code Proficiency Schedule — February 2020 (All times in Eastern Standard Time)

Monday	Tuesday	Wednesday	Thursday	Friday
2/3 4 PM – 2100Z 10 – 35 WPM	**2/4** 7 PM – 0000Z **(2/5 – UTC)** 35 – 10 WPM		**2/6** 10 PM – 0300Z **(2/7 – UTC)** 10 – 40 WPM	**2/7** 9 AM – 1400Z 10 – 35 WPM
	2/11 4 PM – 2100Z 10 – 35 WPM	**2/12** 7 PM – 0000Z **(2/13 – UTC)** 10 – 40 WPM	**2/13** 9 AM – 1400Z 35 – 10 WPM	**2/14** 10 PM – 0300Z **(2/15 – UTC)** 10 – 35 WPM
Presidents Day	**2/18** 9 AM – 1400Z 10 – 35 WPM	**2/19** 10 PM – 0300Z **(2/20 – UTC)** 35 – 10 WPM	**2/20** 7 PM – 0000Z **(2/21 – UTC)** 10 – 35 WPM	**2/21** 4 PM – 2100Z 10 – 40 WPM
2/24 10 PM – 0300Z **(2/25 – UTC)** 10 – 40 WPM		**2/26** 9 AM – 1400Z 35 – 10 WPM	**2/27** 4 PM – 2100Z 35 – 10 WPM	**2/28** 7 PM – 0000Z **(2/29 – UTC)** 10 – 35 WPM

Convention and Hamfest Calendar

Abbreviations
Spr = Sponsor
TI = Talk-in frequency
Adm = Admission

SOUTHWESTERN DIVISION CONVENTION

February 14 – 15, Yuma, AZ

D F H Q R S T

Friday noon – 5 PM, Saturday 8 AM – 5 PM. *Spr:* Yuma AR Hamfest Organization. Yuma County Fairgrounds, 2520 E. 32nd St. Yuma Hamfest. *TI:* 146.84 (88.5 Hz). *Adm:* $5. **www.yumahamfest.org**

ARKANSAS STATE CONVENTION

February 15, Hoxie, AR

D F H R S V

8 AM. *Spr:* Lawrence County ARC. Hoxie Service Center, 500 SW Lawrence St. Winter-Fest 2020. *TI:* 147.045. *Adm:* $5. **www.w5wra.org**

Colorado (Brighton) — Feb. 16 D F H R V
9 AM – 1 PM. *Sprs:* Aurora Repeater Assn., Cherry Creek Young ARC, Rocky Mountain Ham Radio. Adams County Fairgrounds, 9755 Henderson Rd. *TI:* 147.15 (100 Hz). *Adm:* $5. **www.n0ara.org**

Florida (Brooksville) — Feb. 15 D F H R T V
8 AM – 4 PM. *Spr:* Hernando County ARA. Sand Hill Scout Reservation, 11210 Cortez Blvd. (Hwy. 50). *TI:* 146.715. *Adm:* $6. **www.hcara.org**

FLORIDA AMATEUR RADIO EMERGENCY COMMUNICATIONS CONFERENCE

February 29 – March 1, Gainesville, FL

S

Saturday 8 AM – 6 PM, Sunday 12:30 – 6 PM. *Spr:* N. FL ARC. Oaks Baptist Church, 4610 SW Archer Rd. *TI:* 146.82 (123 Hz). *Adm:* Free. **https://qsl.net/nf4rc/**

6th ANNUAL TECHCON

February 21 – 22, Punta Gorda, FL

S

Friday 1 – 5 PM, Saturday 9 AM – 5 PM. *Spr:* ARRL W. Central FL Section. Charlotte County Emergency Operations Center, 26571 Airport Rd. *TI:* 147.255 (136.5 Hz). *Adm:* Free. **www.arrlwcf.org**

Florida (Punta Gorda) — Mar. 7 F H S T
8 AM. *Spr:* Peace River Radio Assn. Punta Gorda Boat Club, 802 W. Retta Esplanade. *TI:* 147.255 (136.5 Hz). *Adm:* $6.

Georgia (Dalton) — Feb. 22 D F H R S T V
8 AM – 2 PM. *Spr:* Dalton ARC. North Georgia Agricultural Fairgrounds, 500 Legion Dr. *TI:* 145.230. *Adm:* $5. **www.w4drc.com**

Indiana (La Porte) — Feb. 29 D F H R V
7 AM – 1 PM. *Spr:* La Porte County ARC. La Porte Civic Auditorium, 1001 Ridge St. *TI:* 146.61 (131.8 Hz). *Adm:* $7. **www.lpcarc.org**

Iowa (McClelland) — Mar. 7 D F H R
8 AM – 1 PM. *Spr:* Southwest Iowa ARC. McClelland Town Hall, 117 Main St. *TI:* 146.82, 442.225 (136.5 Hz). *Adm:* $4. **www.swiradio.org**

Iowa (Perry) — Feb. 29 D F H Q R V
8 AM – noon. *Spr:* Hiawatha ARC. Perry National Guard Armory, 2930 Willis Ave. *TI:* 145.190 (114.8 Hz). *Adm:* $7. **www.qsl.net/kd0neb/**

Kentucky (Cave City) — Mar. 7 D F H Q R T V
7:30 AM. *Spr:* Mammoth Cave ARC. Cave City Convention Center, 502 Mammoth Cave St. *TI:* 146.94. *Adm:* $6. **www.ky4x.org**

Maine (Augusta) — Feb. 15 D F H R V
8 AM – noon. *Spr:* Augusta ARA. Le Club Calumet, 334 W. River Rd. *TI:* 146.67 (100 Hz). *Adm:* $5. **www.w1tlc.org**

Massachusetts (Chicopee) — Mar. 7 D F H R V
8:30 AM – 1 PM. *Spr.* Mt. Tom Amateur Repeater Assn. Castle of the Knights, 1599 Memorial Dr. *TI*: 146.94 (127.3 Hz). *Adm:* $5. **www.mtara.org**

Massachusetts (Marlborough) — Feb. 15 D F H R V
9 AM – noon. *Spr:* Algonquin ARC. Marlborough Middle School, 25 Union St. *TI:* 147.27 (146.2 Hz). *Adm:* $5. **www.n1em.org**

Michigan (Livonia) — Feb. 23 D F H R
8 AM – noon. *Spr:* Livonia ARC. Monaghan Banquet Hall, Knights of Columbus, 19801 Farmington Rd. *TI:* 145.35 (100 Hz). *Adm:* $5. **www.livoniaarc.com/index.php?page=swapshop**

Minnesota (St. Cloud) — Feb. 15 D H Q R S V
9 AM – 1 PM. *Spr:* St. Cloud ARC. Eagles Aerie 662, 730 41st Ave. N. *TI:* 147.015 (100 Hz). *Adm:* $10. **www.w0sv.club/hamfest**

New Jersey (New Providence) — Feb. 22 H R
1:30 PM – 4 PM. *Spr:* New Providence ARC. New Providence High School, 35 Pioneer Dr. *TI:* 147.255/855 (141 Hz). *Adm:* $8. **www.nparc.org**

NEW MEXICO TECHFEST CONVENTION

February 29, Albuquerque, NM

R S

8 AM – 5 PM. *Spr:* Rocky Mountain Ham Radio, New Mexico. NM Veterans' Memorial Event Center, 1100 Louisiana Blvd. SE. *Adm:* $10. *TI:* None. **www.rmham.org/wordpress/new-mexico-techfest**

New York (Hicksville) — Feb. 23 D F H Q R S V
9 AM – 1:30 PM. *Spr:* Long Island Mobile ARC. Levittown Hall, 201 Levittown Pkwy. *TI:* 146.85 (136.5 Hz). *Adm:* $6. **www.limarc.org**

New York (Hoosick Falls) — Feb. 1 D F H R
8 AM – noon. *Spr:* Hoosick Falls ARC. Hoosick Falls High School, Rt. 22. *TI:* 146.655 (100 Hz). *Adm:* $2.

North Dakota (Bismarck) — Feb. 29 F H R S V
7 AM – 1 PM. *Spr:* Central Dakota ARC. Saint Mary's Elementary School, 807 E. Thayer Ave. *TI:* 146.85 (107.2 Hz). *Adm:* Advance $6, door $7. **www.cdarcnd.com**

Ohio (Elyria) — Mar. 1 D F H R
8 AM – noon. *Spr:* Northern Ohio ARS. Lorain County Community College, 1005 N. Abbe Rd. *TI:* 146.7 (110.9 Hz). *Adm:* $7. **www.noars.net**

A = AUCTION
D = DEALERS / VENDORS
F = FLEA MARKET
H = HANDICAP ACCESS
Q = FIELD CHECKING OF QSL CARDS
R = REFRESHMENTS
S = SEMINARS / PRESENTATIONS
T = TAILGATING
V = VE SESSIONS

Ohio (Mansfield) — Feb. 16 D F H R S V
7 AM – 3 PM. *Spr:* InterCity ARC. Richland County Fairgrounds, 750 N. Home Rd. *TI:* 146.94 (71.9 Hz). *Adm:* $7. **www.iarc.club**

Oklahoma (Elk City) — Mar. 7 F H V
8 AM – 3 PM. *Spr:* West Central OK ARC. Clarion Inn, 101 Meadow Ridge Dr. *TI:* 146.76 (88.5 Hz). *Adm:* Advance $5, door $7.

Oregon (Rickreall) — Feb. 15 D F H R
8:30 AM – 3 PM. *Spr:* Salem Repeater Assn. Polk County Fairgrounds, 520 S. Pacific Hwy. *TI:* 145.33 (186.2 Hz). *Adm:* Advance $8, door $10. **www.w7sra.org**

Pennsylvania (South Park Township) — Feb. 23 D H Q R V
8 AM – 3 PM. *Spr:* Wireless Assn. of South Hills ARC. Home Economics Building, 3735 Buffalo Dr. *TI:* 146.955, 443.65. *Adm:* $5 donation.

Texas (Irving) — Mar. 7 F H R V
8 AM – 1 PM. *Sprs:* Irving ARC, Inc. Betcha Bingo Hall, 2420 W. Irving Blvd. *TI:* 146.72 (110.9 Hz). *Adm:* $5. **www.irvingarc.org/**

Texas (Orange) — Feb. 21 – 22 D F H R S T V
7:30 AM – 2 PM. *Sprs:* Orange ARC, Jefferson County ARC, Beaumont ARC. Orange County Convention and Expo Center, 11475 FM 1442. *TI:* 147.18 (103.5 Hz). *Adm:* $8. **www.qsl.net/w5nd/index_files/HAMFEST%20INFO/hamfest%20info.htm**

TEXAS STATE CONVENTION

March 6 – 7, Rosenberg, TX
D F H Q R S T V
Friday noon – 8 PM, Saturday 8 AM – 3:30 PM. *Spr:* Brazos Valley ARC. Fort Bend County Fairgrounds, 4310 TX 36. Greater Houston Hamfest. *TI:* 146.94. *Adm:* Advance $8, door $10. **www.houstonhamfest.org**

VIRGINIA STATE CONVENTION

February 1, Richmond, VA
D F H Q R S V
8:30 AM – 3:30 PM. *Spr:* Richmond Amateur Telecommunications Society. Richmond Raceway Complex, 600 E. Laburnum Ave. Frostfest. *TI:* 146.88 (74.4 Hz). *Adm:* $10. **www.frostfest.com**

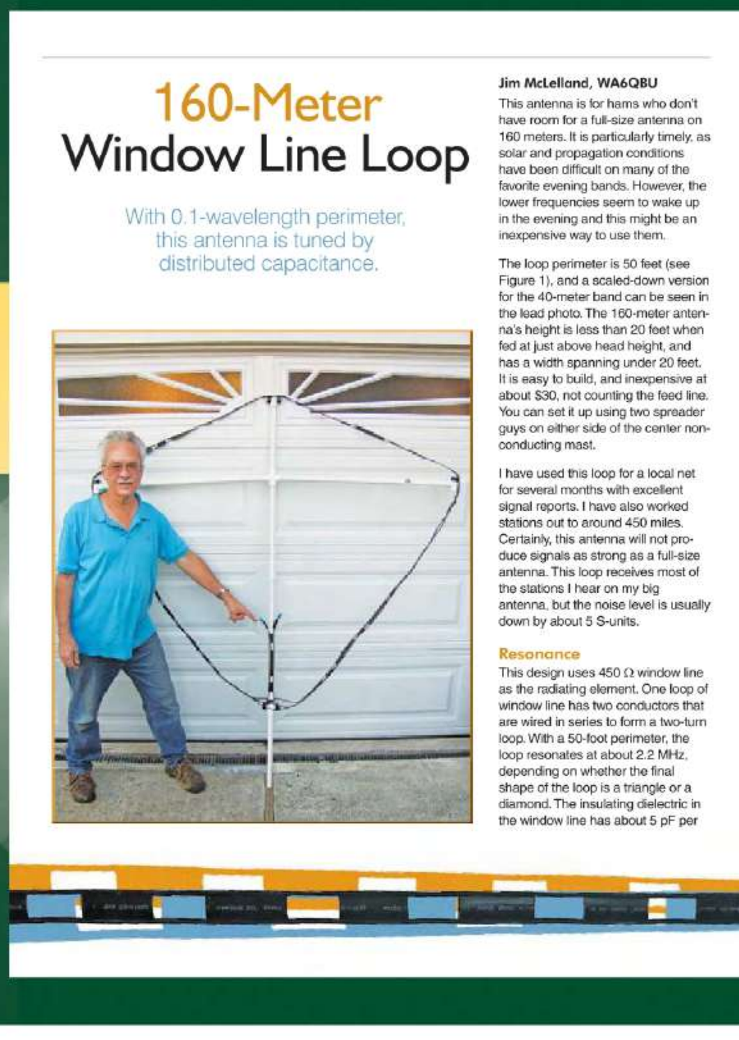
Washington (Puyallup) — Mar. 7 D F H R V
9 AM – 3 PM. *Spr:* Mike and Key ARC. Washington State Fairgrounds, 110 9th Ave. SW. *TI:* 146.82/22 (103.5 Hz). *Adm:* $9. **www.mikeandkey.org/flea.htm**

To All Event Sponsors

When scheduling an event, check the Hamfest and Convention Database (**www.arrl.org/hamfests-and-conventions-calendar**) for events that may already be scheduled in your area on that date. See **www.arrl.org/hamfestconvention-application** for an online registration form.

Your information must arrive at HQ by **March 1** to be listed in the **May** issue. Information in this column is accurate as of our deadline; contact the sponsor or check the sponsor's website for possible late changes and other event details.

As an approved event sponsor, you are entitled to special discounted rates on *QST* display advertising and ARRL web banner advertising. Call ARRL's toll-free number at 1-800-243-7768, or email **ads@arrl.org.**



160-Meter Window Line Loop

With 0.1-wavelength perimeter, this antenna is tuned by distributed capacitance.

Jim McLelland, WA6QBU

This antenna is for hams who don't have room for a full-size antenna on 160 meters. It is particularly timely, as solar and propagation conditions have been difficult on many of the favorite evening bands. However, the lower frequencies seem to wake up in the evening and this might be an inexpensive way to use them.

The loop perimeter is 50 feet (see Figure 1), and a scaled-down version for the 40-meter band can be seen in the lead photo. The 160-meter antenna's height is less than 20 feet when fed at just above head height, and has a width spanning under 20 feet. It is easy to build, and inexpensive at about $30, not counting the feed line. You can set it up using two spreader guys on either side of the center non-conducting mast.

I have used this loop for a local net for several months with excellent signal reports. I have also worked stations out to around 450 miles. Certainly, this antenna will not produce signals as strong as a full-size antenna. This loop receives most of the stations I hear on my big antenna, but the noise level is usually down by about 5 S-units.

Resonance

This design uses 450 Ω window line as the radiating element. One loop of window line has two conductors that are wired in series to form a two-turn loop. With a 50-foot perimeter, the loop resonates at about 2.2 MHz, depending on whether the final shape of the loop is a triangle or a diamond. The insulating dielectric in the window line has about 5 pF per

W1AW Schedule

PAC	MTN	CENT	EAST	UTC	MON	TUE	WED	THU	FRI
6 AM	7 AM	8 AM	9 AM	1400		FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
7 AM-1 PM	8 AM-2 PM	9 AM-3 PM	10 AM-4 PM	1500-1700 1800-2045	VISITING OPERATOR TIME (12 PM-1 PM CLOSED FOR LUNCH)				
1 PM	2 PM	3 PM	4 PM	2100	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
2 PM	3 PM	4 PM	5 PM	2200	CODE BULLETIN				
3 PM	4 PM	5 PM	6 PM	2300	DIGITAL BULLETIN				
4 PM	5 PM	6 PM	7 PM	0000	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
5 PM	6 PM	7 PM	8 PM	0100	CODE BULLETIN				
6 PM	7 PM	8 PM	9 PM	0200	DIGITAL BULLETIN				
6^{45} PM	7^{45} PM	8^{45} PM	9^{45} PM	0245	VOICE BULLETIN				
7 PM	8 PM	9 PM	10 PM	0300	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
8 PM	9 PM	10 PM	11 PM	0400	CODE BULLETIN				

W1AW's schedule is at the same local time throughout the year. From the second Sunday in March to the first Sunday in November, UTC = Eastern US time + 4 hours. For the rest of the year, UTC = Eastern US time + 5 hours.

♦ Morse code transmissions: Frequencies are 1.8025, 3.5815, 7.0475, 14.0475, 18.0975, 21.0675, 28.0675, 50.350, and 147.555 MHz.

Slow Code = practice sent at 5, 7½, 10, 13, and 15 WPM.

Fast Code = practice sent at 35, 30, 25, 20, 15, 13, and 10 WPM.

Code bulletins are sent at 18 WPM.

For more information, visit us at
www.arrl.org/w1aw

♦ W1AW Qualifying Runs are sent on the same frequencies as the Morse code transmissions. West Coast qualifying runs are transmitted by various West Coast stations on CW frequencies that are normally used by W1AW, in addition to 3590 kHz, at various times. Underline 1 minute of the highest speed you copied, certify that your copy was made without aid, and send it to ARRL for grading. Please include your name, call sign (if any), and complete mailing address. Fees: $10 for a certificate, $7.50 for endorsements.

♦ Digital transmissions: Frequencies are 3.5975, 7.095, 14.095, 18.1025, 21.095, 28.095, 50.350, and 147.555 MHz.

Bulletins are sent using 45.45-baud Baudot, PSK31 in BPSK mode, and MFSK16 on a daily revolving schedule.

Keplerian elements for many amateur satellites will be sent on the regular digital frequencies on Tuesdays and Fridays at 6:30 PM Eastern time using Baudot and PSK31.

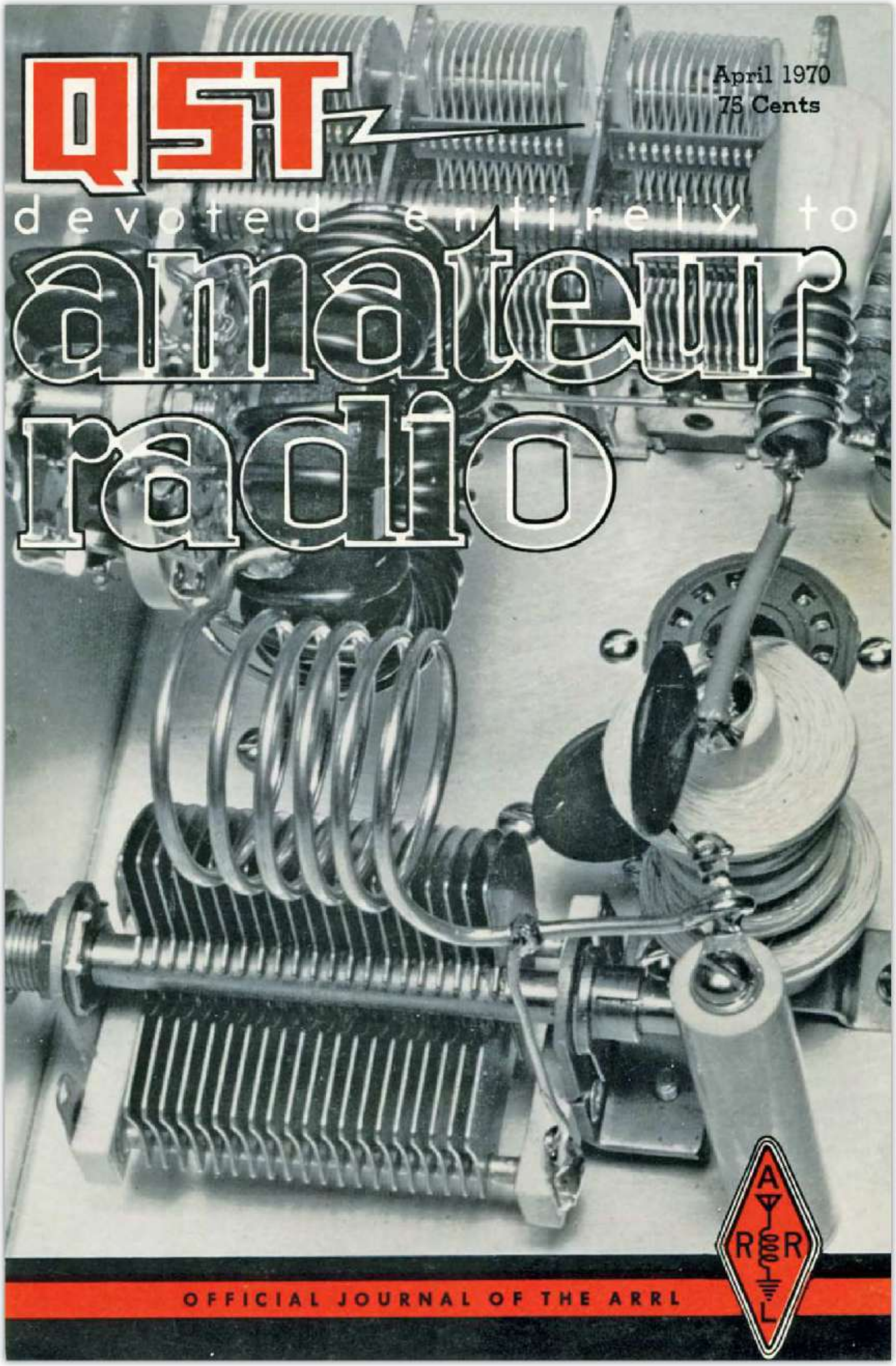
♦ Voice transmissions: Frequencies are 1.855, 3.99, 7.29, 14.29, 18.16, 21.39, 28.59, 50.350, and 147.555 MHz. Voice transmissions on 7.290 MHz are in AM double sideband, full carrier.

♦ Notes: On Fridays, UTC, a DX bulletin replaces the regular bulletins. W1AW is open to visitors 10 AM to noon and 1 PM to 3:45 PM Monday through Friday. FCC-licensed amateurs may operate the station during that time. Be sure to bring your current FCC amateur license or a photocopy. In a communication emergency, monitor W1AW for special bulletins as follows: voice on the hour, teleprinter at 15 minutes past the hour, and CW on the half hour.

W1AW code practice and CW/digital/phone bulletin transmission audio is also available real-time via the *EchoLink Conference Server* W1AWBDCT. The conference server runs concurrently with the regularly scheduled station transmissions. The W1AW Qualifying Run texts can also be copied via the EchoLink Conference Server.

During 2020, Headquarters and W1AW are closed on New Year's Day, Presidents Day (February 17), Memorial Day (May 25), Independence Day (July 4), Labor Day (September 7), Veterans Day (November 11), Thanksgiving and the following day (November 26 and 27), and Christmas (December 25).

A Look Back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OFFICIAL JOURNAL OF THE ARRL
A R R L

Building A "Skinnier Linear"

BY DOUG DEMAW, W1CER

Front view of the one-tube amplifier showing solid-state QRP cw transmitter as an exciter. A homemade aluminum cabinet houses the amplifier. Vent holes are located above the tube, on the top of the enclosure, and the rear opening of the case permits air to enter through perforated-aluminum screening.

A NEW king-size color-TV sweep tube was recently developed by Amperex – a 6LF6. Natural curosity caused the writer to try one in a simple linear-amplifier circuit. The "Skinnier Linear" is the result of the tests made on that huskier-than-average tube.

The 6LF6 has a maximum plate dissipation rating of 40 watts. Earlier sweep tubes were rated at less than 30 watts until such tubes as the 6KD6 appeared on the market. The 6KD6 has a 33-watt rating, and functions very well as a grounded-grid amplifier in the 3- to 30-MHz range.[1] Of course, the extra plate-dissipation allowance of the 6LF6 means that the tube can be socked a little bit harder to provide more output power than the smaller types can safely provide. Maximum plate voltage for the 6LF6 is 990. During the temporary overloads the plate dissipation is rated at 200 watts. Specifications and curves for this tube are given in the Amperex file, *Publication L 509/6LF6.*

* Acting Technical Editor.

[1] "A Sweep-Tube Linear Amplifier," *The Radio Amateur's Handbook*, 46th Edition, page 197.

There are times when adverse band conditions can spell doom for the QRP operator. Whether the mode is cw or ssb, a few extra watts can often assure a "solid" QSO when the going gets a bit rough. This amplifier is designed for the low-power operator, and it will enable him to boost the output power of his QRP transmitter to as much as 175 watts. It can be driven by any solid-state or tube rig whose power output is from one to twenty-five watts. It operates from 3.5 to 21 MHz, and can be used on 28 MHz if one is willing to accept a sacrifice in efficiency.

The tube has an unusually thick envelope, and this feature is intended to prevent the glass from cracking or being sucked in at high temperatures – a problem with some sweep tubes. Amperex states that the glass material is a special heat-resistant variety, and one gets the impression that it is similar to Pyrex when tapping the envelope with a solid object. Additional heat protection is offered by a large anode fin, inside the envelope, and between the main anode structure and the plate cap. The filament requirements are 6.3 volts at 2 amperes.

Using the circuit of Fig. 1, a cw power output of 175 watts was obtained with 25 watts of driving power. Similarly, 175 watts peak output was obtained during ssb tests. The third- and fifth-order distortion products were down 27 dB below PEP level at 120-watts PEP output. At 175 watts PEP output the distortion products were some 25 dB below PEP level. These figures compare favorably with those obtained while testing other sweep-tube amplifiers. At 80 watts PEP output the IMD was somewhat better –– approximately 31 dB below PEP value. Efficiency checks of the amplifier turned up a figure of approximately 60 percent.

The tank circuit is designed for a Q of 10 at 250 watts peak input. No provision was made for 10-meter operation, mainly because of the high output capacitance of the 6LF6 – 18.5 pF. Doubtless, one could tap the 15-meter coil for 10-meter operation, but the total C in the circuit (taking into account the minimum capacitance of the plate tuning capacitor) would be incorrect for the desired tank L-C ratio. The amplifier efficiency would be somewhat less than for the other bands. It is on the order of 50 percent at 15 meters with the present circuit. The 60-percent figure applies at 3.5, 7, and 14 MHz.

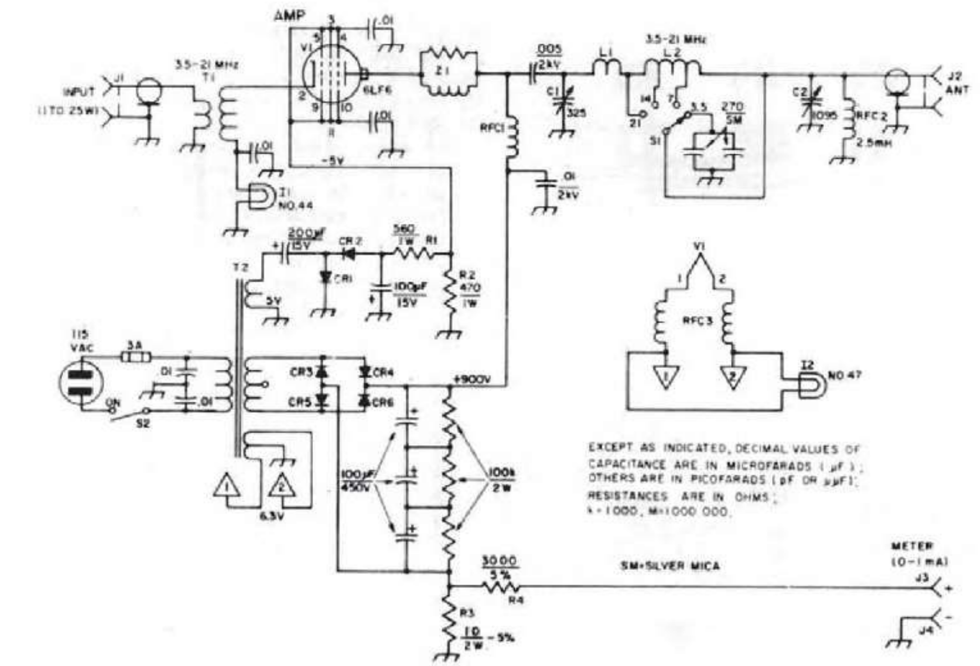


Fig. 1 – Schematic diagram of the linear amplifier. Fixed-value resistors are composition. Fixed-value capacitors are disk ceramic, 600 volts, unless otherwise indicated. Polarized capacitors are electrolytic.

C_1–339-pF variable (Millen 19335 or equiv.).

C_2–Three-section broadcast variable, 365 pF per section, all sections in parallel (J.W. Miller 2113 or similar. Remove trimmers from side).

CR_1 CR_2–50-PRV, 1 ampere silicon diode (Motorola HEP-154 or equiv.).

CR_3–CR_6 incl.–1000-PRV, 1-ampere, silicon diode (Motorola HEP-160, or equiv.).

I_1–No. 44 panel lamp (Fuse and total cathode-current current indicator; See text).

I_2–No. 42 pilot lamp.

J_1 J_2–Chassis connector, SO-239 style.

J3, J4–Nylon binding post, one red, one black (Johnson 111-102 and 111-103 used here).

L_1–5½ turns No. 12 tinned copper wire, 1-inch diameter, 1¼ inches long.

L_2–26 turns No. 12 enam. wire, space-wound to occupy entire area of Amidon T-200 toroid core (Amidon Assoc., 12033 Otsego St., N. Hollywood, Calif. 91607). Tap 13 turns from C_2 end for 7 MHz. Tap 22 turns from C_2 end for 14 MHz.

R_1–R_4 incl. – See text.

RFC_1–Transmitting-type rf choke (Johnson 102-752).

RFC_2–2.5-mH, 100-mA rf choke.

RFC_3–Bifilar-wound filament choke; 50 turns No. 20 enam. on 4-inch length of 0.5-inch diameter ferrite rod (Indiana General CF-503 rod, available from Newark Electronics Corp.). Alternatively, 75 turns No. 20 enam. wire on length of ¾-inch diameter wooden dowel.

S_1–Single-pole, 5-position, single-section, ceramic rotary switch (Centralab PS-101 or equiv., 6 positions unused, see text).

S_2–Spst toggle.

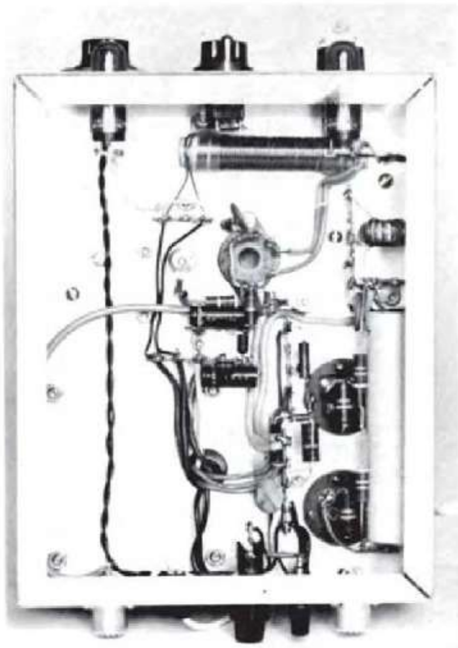
T_1–Toroidal input transformer; Primary – 17 turns No. 26 enam. wire wound to cover two T-68-2 Amidon cores (see text); Secondary – 35 turns No. 24 enam. wire, wound over primary winding.

T_2–Power transformer; 800 volts, center tapped, 200 mA; 6.3 volts at 5 amperes; and 5 volts at 3 amperes (Allied/Knight 54D1414 or equiv.).

Z_1–Parasitic suppressor; 6 turns No. 20 wire in parallel with 56-ohm, 2-watt carbon resistor.

The Circuit

Referring to Fig. 1, a toroidal input transformer, T_1, couples the exciter to the cathode of the tube. It is not a true broad-band transformer because the tube presents a shunt capacitance of 37 pF across the secondary of T_1. This, plus roughly 10 pF of stray circuit capacitance, prevents the transformer from being broad enough for a low SWR on all of the bands. The design center for T_1 is 6 MHz, and it provides an impedance transformation of approximately 4:1. The SWR, as measured at J_1 is less than 2.5 to 1 at 80 and 40 meters. It is 3 to 1 at 15 meters, and a rather high 5 to 1 at 14 MHz. The actual SWR depends upon the operating conditions of the tube at a given power level, and changes with the driving power applied at J_1. Tests were made with an rf choke from cathode to ground, and with a 0.01-uF coupling capacitor between J_1 and the cathode. The SWR on all of the bands was greater than 3.5



Looking into the bottom of the amplifier chassis, the bifilar filament choke is at the far left. T_1, the input transformer, is above the filament choke, and just to the right. A ceramic feedthrough bushing carries the high voltage to the 6LF6 plate. Another bushing is used to route the rf output from C_2 to J_2.

to 1. It is for this reason that the toroidal transformer was used. If a 1-to-1 SWR is desired on the various bands, a pi-section matching network can be installed externally and band-switched. Examples of this technique are given in the transmitting chapter of *The Radio Amateur's Handbook.*[2] However, for all practical purposes, the amplifier performs quite well with T_1 at the input, and only slightly more driving power is needed at 14 MHz for a given dc input power than is required on the remaining three bands.

A No. 44 pilot lamp, I_1, serves a two-fold purpose: It is used as a ¼-ampere fuse to protect the 6LF6, and it provides a visual tuning indicator for adjusting the amplifier. External metering provisions are available at J_3 and J_4. A 0-to-1-mA meter serves as a voltmeter across the jacks, and provides a full-scale reading equivalent to 300 mA. The meter reads the voltage drop across R_3, which increases as the plate current of the tube becomes higher. Resistor R_4 enables the meter to read 3 volts, full scale. Lamp I_1 indicates total cathode current, while the external meter reads only plate current.

A toroidal inductor is used for L_2, and it covers 3.5 through 14 MHz. A separate air-wound inductor, L_1, is used for 15-meter operation, and is a part of the total inductance for the three lower bands. An attempt was made to use a few turns of the toroid coil for 21 MHz, but the Q was too low for good results.

The power supply is connected for full-wave bridge rectification. This provides a dc operating voltage of 900 under load. The power supply regulation is approximately 10 percent with 33-uF of capacitance across the dc line. Three 100-uF capacitors are used in series to provide the voltage rating needed. Equalizing resistors are bridged across the capacitors to assure their safety, and to bleed the supply when it is turned off. Bias is provided by connecting a voltage-doubler circuit across the 5-volt winding of T_2. R_1 and R_2 form a voltage divider that sets the bias to the 6LF6 at −5 volts. This value established a resting plate current at 15 mA.

This amplifier can be operated with 500 volts on the plate, and will deliver up to 75 watts output under that condition. The lower plate voltage may be preferred if the amplifier is to be used for novice-band operation. The bias is lowered to −1 volt for 500 volt operation.

By using filament choke RFC_4 which is bifilar-wound on a ferrite rod, less driving power is needed than if the filament leads were bypassed for rf. The choke can be omitted if ample driving power is available.

Construction Details

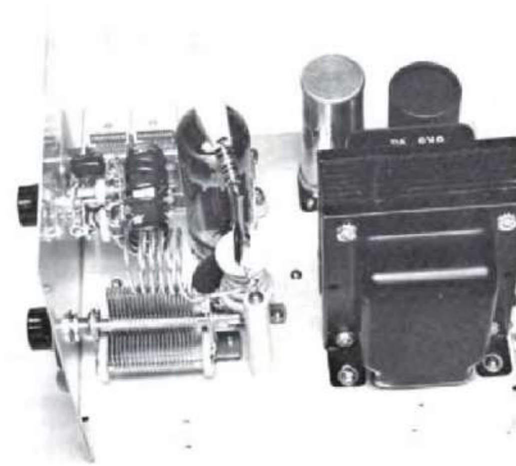
The amplifier and power supply are built on a 7 X 9 X 2-inch aluminum chassis. The cabinet consists of two U-shaped channels which are attached to the sides of the chassis by means of No. 6 sheet-metal screws. The cabinet is 7½ inches high, and is 7 inches wide. The panel is recessed ½ inch, making the cabinet depth 9½ inches. Two vent holes, each 2½ inches in diameter, are centered on a line four inches back from the front edge of the cabinet. Perforated aluminum serves as TVI shielding, but permits the heat to escape from the cabinet. The rear opening of the cabinet is enclosed with perforated aluminum as an aid to TVI prevention. Self-adhesive rubber feet are used on the bottom of the cabinet.

The aluminum for the cabinet was abraded with coarse emery cloth to give it a grained appearance. It was then immersed in a lye bath *(caution used here against physical contact with the bath)* to obtain the satin finish. A coating of clear spray lacquer was then added as a protective finish. The front panel was sprayed with French gray, and black decals were added for identifying the controls.

Referring to Fig. 1, the top 100-uF filter capacitor in the power supply is a tubular type with a cardboard case. It is mounted under the chassis on terminal strips (see photo) and is safe with regard to physical contact. The center 100-uF filter capacitor is a twist-lock type, and is mounted above the chassis. It has a cardboard outer cover to prevent physical contact with its metal case. If this were not done the operator could get a severe shock if the capacitor case was touched while some

[2] "A Tuned Input Circuit for Grounded-Grid Amplifiers," *QST*, May 1968, page 34.

Inside view of the amplifier. The power supply is at the right of the photo, and the rf section is assembled near the front panel. It is suggested that the 6LF6 tube be moved farther away from the toroidal inductor when duplicating this amplifier. In this model the tube transfers considerable heat to the coil, an undesireable condition.



other part of his body was in contact with the ground. The bottom capacitor has only a few volts between its case and ground, so it need not be covered. The two top-chassis electrolytics are mounted on phenolic insulating bases to isolate them from the chassis. Make sure that all three capacitors are of the same value if substitutions are made. If not, the voltage division across them will be unequal, and one may be damaged by excessive potential.

Toroidal coil L_2 is wound with No. 12 enameled wire. Care should be taken to minimize the stress on the core when winding L_2. Too much tension can break the core, but if it does break it can be repaired with epoxy cement, and it will perform as well as before being broken. The insulation should be scraped off the wire where the taps are placed, and each spot tinned with solder. This can be done as the coil is being wound. The toroid is mounted directly on S_1 by its tap leads, which should be fairly stiff bus wire, No. 14 or larger. The switch has several unused terminals, and these serve as tie points for mounting the toroid. Wires can then be run from the tie points to the appropriate switch lugs for proper indexing. A 4-inch-long ceramic pillar serves as a mounting point for the plate blocking capacitor, and for one end of L_1.

The input transformer, T_1, uses two small Amidon toroid cores, stacked. Before winding the transformer place a narrow strip of masking tape around the outer perimeter of the cores to hold them together. Alternatively, the cores can be cemented together with epoxy glue. Two cores were used for T_1 to assure adequate power-handling capability.

TABLE I

Driving Power (watts)	Output Power (3.5-14 MHz.)	(21 MHz)
1.5	22	19
2	25	22.5
5	42	37
8	60	54
15	70	63
20	90	80
22	130	115
25	175	157

This chart shows the rf output power obtained from the linear amplifier at various driving-power levels. The tank circuit was tuned for maximum output. Part of the driving power is represented in the power-output figures given here.

Using the Amplifier

Table I shows the amount of power output that can be expected with several values of driving power. No more than 25 watts of drive should be used if damage to the tube is to be prevented. It can be seen that even a small exciter of 1.5 watts output will drive this amplifier. Tests were made with the QRP 80-40 solid-state rig[3] as an exciter. Power output from the linear amplifier was 22 watts, a worthwhile increase indeed.

With drive applied at J_1 tune C_1 for a dip in lamp brilliance at I_1. Adjust C_2 for the desired amount of loading. Best efficiency will occur with moderate coupling to the load. During cw operation the amplifier can be tuned for maximum power output as indicated on an SWR meter or rf ammeter. For ssb use, couple the amplifier rather tightly to the load for best signal quality. C_2 should be adjusted until the dip in plate current is no greater than 10 or 15 mA. QST

Strays

Pacific Division Director W6ZRJ explains Oscar circuits to Fremont High School Bandjammers president WA6BXH and WB6DSV. The club has been active with all Oscars, helping at Oscar HQ, and operating their own tracking station.

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Celebrating Our Legacy

Radio Evolution

I have been fascinated by electronics since my folks got me a crystal radio kit one Christmas. I became licensed in 1969 as a Technician and began by using an old Lafayette 6-meter rig, but lack of activity moved me toward the HF bands and CW. I used some borrowed QRP rigs to work a decent amount of domestic contacts and a few DX contacts in the Novice HF bands, but *really* wanted to work 20-meter phone!

In the early '80s, I got my first "real" rig, a used Yaesu FT-101. I loved it, but as I listened to all the SSB activity, I couldn't stand it anymore, so I got a RadioShack Morse code practice record (I still have it!) and got up to 15 WPM. I took the 13 WPM test in Reno, Nevada and finally had my General-class license. Look out, 20 meters! When the sunspots were hot, I could work the world with that rig.

As time marched on, I eventually upgraded to an Icom IC-718, and most recently to an Icom IC-7300. I still miss the days of big tube radios but recognize the amazing capabilities and comparative low cost of the modern rigs.

As a working electrical engineer for many years, I embrace the changes and the technology, but still have some nostalgic memories of the older equipment, which is, I suppose, why I have a few tube rigs sitting around in my shop!

Dave Telling, KJ7WT
Carson City, Nevada

Covert Apartment Antenna

As a college student in 1968, I built my own rock-bound, two-tube transmitter from a plan in *QST* or *The ARRL Handbook* by feeding a long wire running about 5 W on 80 and 40 meters. The receiver was a Hammarlund HQ-110. We lived in a two-story apartment building with external antennas forbidden. I unwound an old speaker magnet, probably #30 or #32 enameled wire, fed it out of the back window, and attached it to the eave of the building for around 100 feet — it worked. There was not a lot of time for contacts, but I looked at the logbook recently and found a surprising number.

Raymond Harrill, WA5GSC
Little Rock, Arkansas

Celebrating 73 Years as a Ham

I have been a ham for over 50 years. I became a ham because of my uncle John, W8ZXP, who was first licensed in 1947 and, as far as I know, has been active for all these years. He celebrated his 101st birthday in September 2019. At the Royal Palms Retirement Centre in Port Charlotte, Florida, he has a ham's dream setup — an antenna farm. I believe there are six to eight different antennas, some commercial and some homebrew.

When my uncle was newly married and living in the apartment above my grandparents' house, he asked my grandfather if he could put up a tower on his small Cleveland city lot. My grandfather, who was very strict, said absolutely not! Eventually my grandmother ruled against him and my uncle was able to hand-construct his tower from 2-foot sections of aluminum.

Bill, K8IDT; Jack, K8UYC, and John, W8ZXP (seated).

Jack Magar, K8UYC
Millsboro, Delaware

Send reminiscences of your early days in radio to "Celebrating Our Legacy," ARRL, 225 Main St., Newington, CT 06111 or **celebrate@arrl.org**. Submissions selected for publication will be edited for space and clarity. Material published in "Celebrating Our Legacy" may also appear in other ARRL media. The publishers of *QST* assume no responsibility for statements made in this column.

George J. Misic, KE8RN, ke8rn@comcast.net

Classic Radio

The Hammarlund HQ-110 Receiver

The Hammarlund HQ-110 receiver entered the ham radio market in 1957 and was sold until 1962. In 1961, the upgraded HQ-110A became available and was manufactured until 1969 (see the lead photo). The Hammarlund HQ-110 family of ham band receivers were of good quality, but were often thought to be poor receivers because they shared a cabinet with the mediocre Hammarlund HQ-100 and HQ-100A, introduced in 1956. Hammarlund sold the larger and more expensive HQ-170, HQ-170A, and HQ-170A-VHF receivers from 1958 to 1967.

The Hammarlund HQ-110A. [Markus Hansen, VE7CA, photo]

Specifications

The receiver weighed about 30 pounds and was 16.2 inches wide, 9½ inches high, and 9.2 inches deep, excluding the knobs, fittings, and feet. All the Hammarlund HQ receivers (besides the HQ-215) shared a common look. The HQ family had two tuning dials, an S-meter that was often in the center, and an optional clock in the left corner (see Figure 1). Below the dials were two large knobs, one of which was the main tuning knob. On general-coverage receivers, the left dial was the general-coverage dial and the right dial was the ham bandspread. The right knob was the function switch on the HQ-110 family of receivers.

The HQ-110 receivers were dual conversion with a first intermediate frequency (IF) of 3045 kHz and a second IF of 455 kHz. The receiver was single conversion on 80/75 and 160 meters, using only the 455 kHz IF. The HQ-110 and HQ-110A covered 160 to 6 meters without the WARC bands and the HQ-110A-VHF added the 2-meter band.

Circuit Designs

The HQ-110 and HQ-110A were similar in design and used the same tubes. The HQ-110 line of receivers were not designed like the under-performing HQ-100 and HQ-100A, but were much more similar to the larger Hammarlund HQ-145 and HQ-145A dual-conversion, general-coverage receivers.

All the HQ-110s used a type 6BZ6 pentode tube as the RF amplifier. A 6BE6 pentagrid converter was used as the first mixer, with a separate 6C4 triode as the tuneable first-conversion oscillator. A second 6BE6 was used as the second mixer, which was also the oscillator for the conversion to 455 kHz from 3045 kHz. A 6BA6 pentode was used as the first IF amplifier at 455 kHz, and a 6AZ8 pentode as the second IF and the beat-frequency oscillator (BFO). The BFO was separate from the Q-multiplier circuit, unlike in the HQ-100. The Q multiplier operated at 455 kHz and used a 12AX7 tube. A 6BJ7 served as the diode detector, automatic noise limiter (ANL), and automatic gain control (AGC) diode. A common 6AQ5 was used in the audio output stage, providing about 1 W of audio power to a 3.2 Ω external speaker.

The AGC and ANL built into the HQ-110 receivers only operated when receiving AM signals. The HQ-110 receivers did not include a product detector for better performance on SSB and CW. The similar but larger general-coverage HQ-145 and HQ-145A also did not have product detectors. For $100 more, the ham band HQ-170/170A and the general coverage HQ-180/180A were supplied with product detectors and variable speed AGC on SSB and CW. The HQ-110 family did have an RF gain control with a very wide

Figure 1 — A front view of the Hammarlund HQ-110A (note the space in the upper left corner for an optional clock). [Markus Hansen, VE7CA, photo]

range that allowed SSB and CW to be well received by setting the RF gain low enough to avoid distortion.

Power Supply

All the HQ-110 type receivers used a 5U4GB vacuum tube as the B+ rectifier. The HQ-110A did not move to solid-state silicon diodes when advancing to the later model upgraded A versions like the HQ-145, HQ-170, and HQ-180 did when becoming the HQ-145A, HQ-170A, and HQ-180A. All models except the HQ-200 used gas-filled voltage regulator tubes. The HQ-110s used a 0B2 regulator tube, regulating at about 108 V dc.

Options and Accessories

None of the Hammarlund communication receivers had built-in speakers, so the company sold two speakers with similar styling to be used with all receivers mentioned. The S-100 speaker was the smaller of the two, and the S-200 was larger. All speakers and outputs were rated at 3.2 or 4 Ω, but worked fine with 3.2 to 8 Ω speakers. All receivers had a ¼-inch monophonic phone jack. Most were located on the rear panel and muted the speaker when the headphone plug was inserted. All had provisions to mute the receivers when an amateur station was transmitting.

Clocks were also an option for many models of Hammarlund receivers. In general, a 12-hour clock was supplied with the original offerings and 24-hour clocks were supplied for the "A" models. The clock could actually be set to turn on the receiver before the operator planned to use it, thus allowing the unit to fully warm up and minimizing the amount of frequency drift the user had to deal with. A factory-supplied clock added a "C" to the model number, but owners could also purchase and install the clock on their own.

For units sold in areas where the ac power voltage was 220 – 240 V ac, Hammarlund marketed a version that could operate from 110 – 120 V ac or 220 – 240 V ac. These radios featured an added "E" on the model number to signify provisions for export power. The Hammarlund HQ-110 family all came with built-in 100 kHz crystal calibrators.

The HQ-110A and 110A-VHF

The HQ-110A gained a dial scale for use with a 2-meter converter that had a 6-meter output. The converter built into the HQ-110A-VHF used four RCA 6DS4 Nuvistor triode tubes. The HQ-110A also gained a separate antenna input for 6 meters that was separate from the input for 160 to 10 meters. The separate 6-meter antenna input was a very big plus, as a different antenna was virtually always used for 6 meters rather than the other bands.

A 6-meter preamplifier was also provided in the HQ-110A-VHF using two 6DS4 Nuvistor tubes. The separate input for the 6-meter antenna aided Hammarlund in adding the 2-meter converter and 6-meter preamplifier. To select the 2-meter converter, the receiver was set up for 6-meter reception. The 2-meter converter was selected by pulling out the RF gain control. Relays put it in front of the 6-meter input and a separate 2-meter antenna input fed the converter.

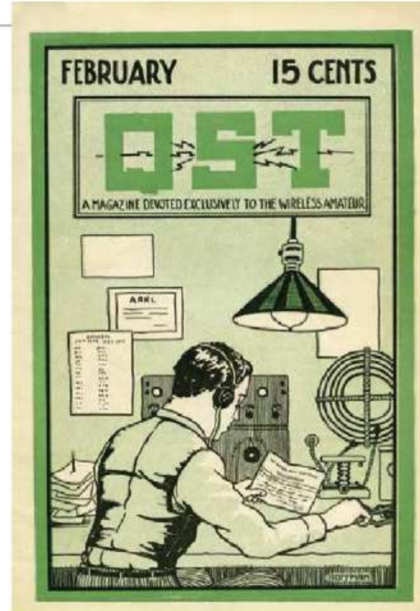
1960s Competitors

Drake started in the receiver business in 1957 with their 1A receiver, designed for SSB and CW operation rather than AM. The Drake receivers moved on to the 2A, the well-known 2B, and the 2C while the Hammarlund HQ-110 family was on the market. The Hammarlund HQ-110 family covered 160 and 6 meters with the option for 2 meters, which the Drake receivers did not. The Drake receivers used a crystal-controlled, first-conversion, tuneable IF plus product detectors, which really boosted the SSB and CW operation while improving stability and frequency readout.

By picking up on advances made by Collins Radio, in 1963 Heathkit managed to pull ahead of Hammarlund, Hallicrafters, National Radio Company, and RME (Radio Manufacturing Engineers) in terms of SSB/CW operation and frequency readout and stability. This set the stage for the next decade of radio manufacturing.

Al Brogdon, W1AB

100, 50, and 25 Years Ago



February 1920

- The cover artwork shows a ham pounding brass as he transmits a radiogram.
- The editorial discusses "Reducing 'Legitimate' Interference."
- Edwin Armstrong presents "A New Method for the Reception of Weak Signals at Short Wave Lengths."
- Sumner B. Young discusses "Spark Coil Transmitter Design."
- "Traffic Rules and Regulations of the ARRL" explains proper traffic-handling techniques to the new operator.
- In "Speaking of Grounds," H.E. Rawson shares tips on how to get the best possible station ground.
- The "Amateur Radio Stations" column looks at 2PL this month, who offers some of his "splendid" ideas.

February 1970

- The cover photo shows W2GB and W8JDV looking over some old-time radio gear at a recent Antique Wireless Association convention.
- The editorial discusses the hazards and safety measures involved with installing antenna towers.
- A.E. Schwaneke, WØGS, presents a wealth of good information on "Equipment Modification for the Blind."
- Larry Walrod, VE7BRK, describes how he built "A Sturdy 80-Foot Mast."
- Lew McCoy, W1ICP, explains "How to Wind Your Own Power Transformer."
- O.G. Villard, W6QYT; C.R. Graf, W5LFM, and J.M. Lomasney, WA6NIL, look again at the phenomenon of long-delayed echoes of radio signals, in "There Is No Such Thing As A Long-Delayed Echo AR."
- Robert Stoffels offers Part 4 of "Let's Talk Transistors."
- Albert Kahn, K4FW, reviews some unsolved mysteries of ham radio (when things do not go as planned) and explains "Witchcraft, Goblins, Hexes, and Gremlins."

February 1995

- The cover photo shows Fred Cady, KE7X, checking the antennas of the W7LR repeater in the snow, high atop Montana's Eaglehead Mountain.
- The editorial, "Going Once…," presents recent FCC actions in the auctioning of spectrum near 900 MHz for narrowband Personal Communication Service (PCS) use, which brought in billions of dollars to the US Treasury.
- Darrel Emerson, AA7FV/G3SYS, gives a fascinating report on "Radio Observations of Two Solar Eclipses."
- "Hams at the New York City Marathon," reports that in 1994, 400 hams provided communication support for the event.
- Floyd Koontz, WA2WVL, describes a simple receiving antenna for 80- and 160-meter DXing, in "Is this Ewe for You?"
- Jerry Hall, K1TD, discusses "Interpreting *QST*'s New Propagation Charts for Low Power and Low Antennas."
- Gil McElroy, VE1PKD, takes readers back to olden times, in "Remembering Hugo Gernsback."
- Jeff Reinhardt, KM6II, talks about the conversion of a former postal van into a ham radio emergency communications van, in "A Van for All Reasons."
- Jack Columbus, VE1XT, shares his experiences in England, in "A Ham's Tour of London."
- Paul Danzer, N1II, reminds readers of the dangers present when there is a "Baby in the Shack!" He offers good suggestions on how to avoid potentially dangerous practices.

Silent Keys

It is with deep regret that we record the passing of these radio amateurs:

KA1AQP	**Kenadek**, Richard D., West Millbury, MA
W1CCL	**Edwards**, Robert K., South Yarmouth, MA
KZ1D	**Brevik**, Dennis J., Middleborough, MA
K1DKX	**Skrzypczak**, Bernard, Barre, MA
K1INX	**Woods**, Norman E., Jr., Polk City, FL
KD1IY	**Birch**, Dennis J., Medway, MA
N1JRV	**Chenard**, Napoleon S., Norwalk, CT
W1LBC	**Coursey**, Lloyd B., Marietta, GA
WK1M	**Howard**, George A., Jr., Ansonia, CT
AG1O	**Crawford**, Eldon E., Sr., Cumberland, RI
•K1RES	**Williamson**, Peter C., Augusta, ME
W1TQW	**Rothman**, Robert H., Providence, RI
•W1UNT	**Russo**, Philip A., Melrose, MA
N1URO	**Rogers**, Richard B., Unionville, CT
♦KA2ANX	**Tolbert**, James H., Knoxville, TN
N2CCR	**Rabey**, Charles D., Jacksonville, FL
♦N2CQ	**Newman**, Kenneth Dwaine, West Deptford, NJ
•K2DBE	**Nichols**, William C., Carmel, NY
•WA2DLH	**Swartz**, David J., Baldwinsville, NY
•KC2FRK	**Feury**, Peter T., Bound Brook, NJ
N2GRQ	**Franco**, Jose R., Corona, NY
K2IUC	**Dawson**, Daniel K., Jr., Leesburg, FL
KD2JRV	**Kuzmicki**, Robert P., Spencerport, NY
N2KUR	**Carman**, Foster H., Ballston Lake, NY
KC2KYN	**Maeder**, Dolores E., San Benito, TX
N2LYV	**Mangano**, Dominick, Grand Rapids, MI
KD2OTM	**Baumgras**, Edward F., Baldwinsville, NY
N2RID	**Gubbins**, Douglas, New Berlin, NY
♦KJ2V	**Reeder**, George T., Jr., McMinnville, OR
WA2VIY	**Lazarus**, Lester, Ho-Ho-Kus, NJ
N2VUG	**Schuman**, William S., Hopatcong, NJ
•K3CFA	**Acker**, Carl F., Felton, DE
K3CTO	**Dean**, Chuck N., Columbia, MD
WB3CUW	**Geiselman**, David A., North Huntingdon, PA
♦N3CXY	**Ibaugh**, Sharon G. "Shari," Landisville, PA
W3DAD	**Arber**, Kevin, Savage, MD
N3KGC	**Hillman**, Ronald W., Lake Township, PA
•KA3MMM	**Austin**, Elwood H., Harrisburg, PA
•K3QIF	**Gardenhour**, Harold R., Waynesboro, PA
K3RYZ	**Hoover**, Ronald L., Allentown, PA
KZ3V	**Smith**, Clifford B., York, PA
KX4AU	**Badgett**, Dalmer Mitchell, Greensboro, NC
N4CBO	**Lowman**, Robert W., Florence, SC
KM4CSH	**Howell**, Adrian, Smithfield, NC
N4CVN	**Shelton**, James H., Chesapeake, VA
KQ4DC	**Walker**, Ed, Mount Pleasant, SC
KK4DD	**Brown**, Thomas H., Gadsden, AL
W4EIB	**Shawver**, Carl D., Tampa, FL
KE4GZD	**MacDonnell**, Steve M., Spencer, TN
W4HKY	**Setzler**, John M., Hickory, NC
KM4HND	**Lee**, William L., Pensacola, FL
K4HOA	**Gaver**, Frank E., Henry, VA
•W4HWF	**Whitten**, George A., Eden, NC
♦K4IES	**Zimmerman**, Ralph K. "Zim," Lake Stevens, WA
W4IHR	**Glancy**, Rodney K., Lexington, KY
♦W4LFP	**Andrus**, Paul F., Penney Farms, FL
K4LJA	**Prewitt**, Randall B., Monroe, LA
WA4LXK	**Cheatwood**, William K., Montgomery, AL
♦K4MGP	**Patrick**, Charles R., Clarksville, TN
W4MLU	**Upchurch**, Michael L., Raleigh, NC
KF4NIS	**Wentzel**, Seth P., Princeton, NC
W4NIX	**Smith**, Raphael F., III, Nashville, TN
WA4NRA	**Moody**, John R., Fuquay-Varina, NC
KK4OIH	**Strickland**, Tommy E., Sims, NC
KK4OOO	**Kulow**, Nancy, Cary, NC
KO4PD	**Finch**, Donald R., Trinity, NC
WA4PIL	**Hauser**, Ralph F., Jr., Fort Myers, FL
♦N4PN	**Newberry**, Paul H., Jr., Macon, GA
♦W4RI	**Rinaldo**, Paul L., Fairfax, VA
KI4SBL	**Freeman**, Robert A., Cumming, GA
W4TKD	**Wingfield**, John D., Macon, GA
KC4WQQ	**Gross**, Jerry L., Evansville, IN
W4YTC	**Forrester**, Ray W., Sr., Rainbow City, AL
KM4YUL	**Hondurski**, John A., Lake Wales, FL
W5CVE	**Harwood**, Ed D., Ardmore, OK
♦K5DJ	**Stailey**, Ron J., Farmington, NM
N5DLL	**Brumley**, Carman M., Huntsville, TX
KC5DTN	**Hughes**, Lee H., Lubbock, TX
WA5FDJ	**Eubanks**, Verlon R., Sr., Windom, TX
W5GNF	**Nelson**, Paul C., Ames, IA
♦K5IOJ	**Inks**, Mickie R., Gatesville, TX
•W5NF	**Lockerd**, Ben G., Fort Smith, AR
WA5NRG	**Stockholm**, C. Jerry, Beaumont, TX
KC5VJU	**Burnett**, James L., Tatum, NM
W5VXG	**Lovell**, Odus W., Jr., Joelton, TN
K5YAA	**Chouinard**, Gerald J., Claremore, OK
KM5ZA	**Westberry**, Charles H., Columbus, MS
W6ARM	**Melcher**, Alton R., Clovis, CA
K6AV	**Robinson**, Jerry, Los Angeles, CA
KE6BQC	**Davis**, Lowell "Buzz," Solvang, CA
N6BRR	**Franke**, Gerry G., Paso Robles, CA
WB6CYT	**Kantor**, Brian H., San Diego, CA
K6DME	**Gunn**, Ruffner B., III, Rio Vista, CA
♦K6DYT	**Cross**, William L., Oroville, CA
W6DZM	**Christensen**, Donald E., Santa Rosa, CA
N6GIP	**Redding**, Henry, Orange, CA
K6HNZ	**Ruddock**, Kenneth A., San Jose, CA
N6IBI	**Coven**, Cybyl C., Gold Bar, WA
N6KW	**Miller**, Charles N., Seattle, WA
K6RFB	**Van Zeyl**, Edward D., Yucaipa, CA
N6RWJ	**Jervis**, Richard W., La Quinta, CA
KF6RXB	**Phelps**, Paul L., Point Reyes Station, CA
KB6UNC	**Reid**, Dan W., Salt Lake City, UT
WB7CJU	**Springfield**, John J., Carrollton, TX
♦KB7DD	**Dallon**, Dale R., Maricopa, AZ
AB7HR	**Greenhalgh**, Dennis R., Wilford, ID
KN7M	**Cross**, Myrna L., Mesa, AZ
WN7M	**Attwell**, Roger J., Everett, WA
KC7MDN	**Sim**, Fred A., Bountiful, UT
KB7NLA	**Thurman**, Michael D., Wendell, NC
♦KL7NO	**Noe**, Albert, Fairbanks, AK
KB7ORF	**McClain**, Hoyt L., Pinehurst, ID
W7THT	**Casey**, Paul H., La Quinta, CA
♦W7THY	**Hartung**, John W., Washington, UT
WA7TUV	**Jenkins**, Richard S., Springfield, OR
N7VEY	**Hesse**, Eugene G., Coldwater, MI
KI7VTV	**Duncan**, William C., Portland, OR
♦NE7W	**Lindsay**, Allan W., Sparks, NV
K8APD	**Brown**, A. Doug, Franklin, WV
KC8BAR	**McDowell**, John W., Reed City, MI
WB8BUT	**Lahmann**, William J., Venice, FL
W8CAM	**Washburn**, Carman A. "Buz," Saginaw, MI
•WD8CQS	**Knight**, Joyce R., Fremont, OH
K8CZG	**Linley**, Ralph W., Midland, MI
KA8DAL	**Quinlan**, Patrick Robert, Canton, OH
KB8GLH	**Rucker**, John S., Clendenin, WV
•KA8GYQ	**Lavrich**, James H., East Windsor, NJ
WA8TPP	**Ingraham**, Richard E., Mentor, OH
KD8TR	**Colestock**, Robert L., Bay City, MI
K8TSB	**Selders**, Kenneth, Elkins, WV
KD8YSL	**Klint**, William E., Tipp City, OH
N9BAU	**Mansfield**, Garrett E., Princeville, IL
KC9DC	**Stucker**, James A., Tomball, TX
KE9IN	**Remling**, Ronald R., Sheboygan, WI
•K9KHZ	**Ashley**, Jack L., Lake Wales, FL
KA9KOG	**Grimm**, Bennie L., Avilla, IN
W9MRK	**Kubik**, Felix, Jr., Evergreen Park, IL
W9NJD	**Strandlund**, Doyle V., Columbia City, IN
K9RAG	**Gerber**, Richard A., Indianapolis, IN
N9VBA	**Pagenkopf**, Donald R., Kronenwetter, WI
K9ZWH	**Palambo**, Robert, St. George, UT
•NØBIQ	**Johnson**, Neal A., Kansas City, MO
♦KCØCA	**Kidd**, Eugene D., St. Louis, MO
WBØESV	**Beck**, Martin O., Wichita, KS
♦WØGBM	**Mattox**, Gilbert B., Omaha, NE
KCØIBL	**Barnes**, Sidney E., Longmont, CO
WØJT	**Toscano**, John P., New Braunfels, TX
♦KØLG	**Green**, Byron "Les," Macclenny, FL
KØLND	**Storer**, Freddy A., Offerle, KS
WAØMNA	**Davisson**, Vance K., Riverside, IA
WØMRI	**Bradley**, Aubrey J., "Brad," Jr., Wichita, KS
NØOBY	**Smith**, John W., Hutchinson, KS
KDØOTB	**Eggers**, William I., Marine on Saint Croix, MN
KDØPQG	**Miller**, Michael A., Fargo, ND
KØUBK	**Reich**, Herbert C., Saint Paul, MN
NØXCG	**Taylor**, Gary L., Kansas City, MO
VE3GTH	**Graham**, Ivan E., Belleville, ON, Canada
VA3RD	**Thompson**, Bob, Sarnia, ON, Canada
VA3RE	**Edge**, Robert L., Hamilton, ON, Canada
VE3XJD	**Dixon**, Jamie "Jim," ON, Canada
VE3XT	**Unger**, Bill, Thunder Bay, ON, Canada
OZ3FI	**Ellermann**, Finn, Randers, Denmark

In the October 2019 *QST* Silent Key column, Dean R. Thompson, Athens, AL, should have been identified as ex-WWØL.

♦ Life Member, ARRL

• Former call sign

For information on how to list a Silent Key in *QST*, please visit **www.arrl.org/silent-key-submission-guidelines**.

Note: Silent Key reports must confirm the death by one of the following means: a copy of a newspaper obituary notice, a copy of the death certificate, or a letter from the family lawyer or the executor. Please be sure to include the amateur's name, address, and call sign. Allow several months for the listing to appear in this column.

Many hams remember a Silent Key with a memorial contribution to the ARRL Foundation or to ARRL. If you wish to make a contribution in a friend or relative's memory, you can designate it for an existing youth scholarship, the Jesse A. Bieberman Meritorious Membership Fund, the Victor C. Clark Youth Incentive Program Fund, or the General Fund. Contributions to the Foundation are tax deductible to the extent permitted under current tax law. Our address is: The ARRL Foundation Inc., 225 Main St., Newington, CT 06111.

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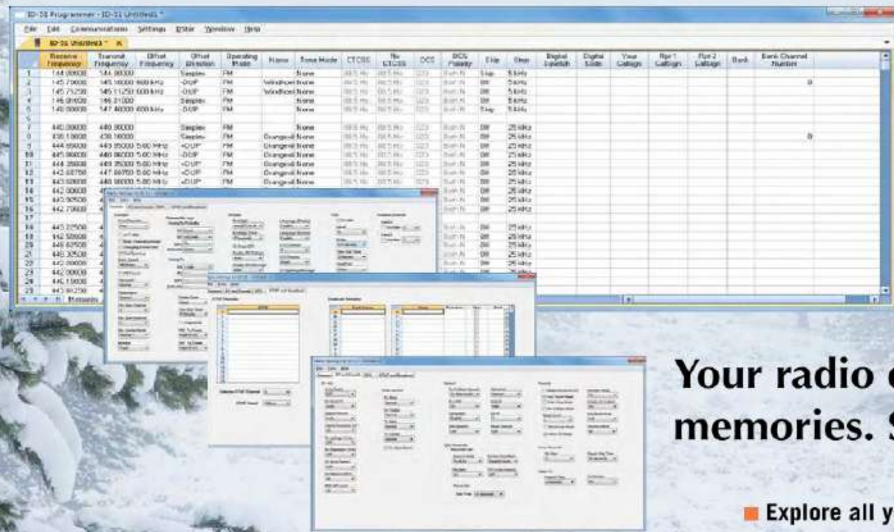

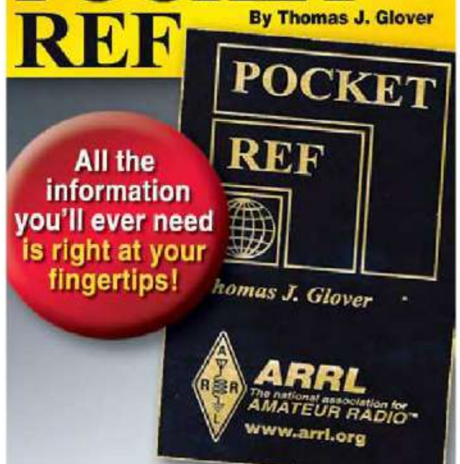
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For medium communications arrays up to 15 square feet wind load area. Has 5-second brake delay, Test/Calibrate function. Low temperature grease permits normal operation down to -30 degrees F. Alloy ring gear gives extra strength up to 100,000 PSI for maximum reliability. *Precision* indicator potentiometer. Ferrite beads reduce RF susceptibility. Cinch plug plus 8-pin plug at control box. Dual 98 ball bearing race for load bearing strength and electric locking steel wedge brake prevents wind induced movement. North/South center of rotation scale on meter, low voltage control, max mast 2$^{1}/_{16}$".

HAM-VI – $809.95 with DCU-2

HAM-VII – $959.95 with DCU-3

Specifications	
Wind Load Capacity (inside tower)	15 square feet
Wind Load (w/mast adapter)	**7.5 square feet**
Turning Power	800 in.-lbs.
Brake Power	**5000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Dual race/96 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	26 lbs.
Effective Moment (in tower)	**2800 ft.-lbs**

TAILTWISTER SERIES II – $869.95

For Large Medium Antenna Arrays up to 20 sq. ft. wind load.

Has 5-second brake delay, Test/Calibrate functions. Low temp grease, tough alloy ring gear, indicator potentiometer, ferrite beads on potentiometer wires, weatherproof AMP connectors plus 8-pin plug at control box, triple bearing race with 138 ball bearings for large load bearing, electric locking steel wedge brake, North/South center of rotation scale meter, low voltage control, 2$^{1}/_{16}$" max mast. **MSHD, $139.95.** Above tower heavy duty mast support. T2X, HAM-IV, HAM-V, HAM-VI. Accepts 1$^{7}/_{8}$-2$^{5}/_{8}$" OD.

T-2XD2 – $979.95 with DCU-2

T-2XD3 – $1039.95 with DCU-3

Specifications	
Wind Load Capacity (inside tower)	20 square feet
Wind Load (w/mast adapter)	**10 square feet**
Turning Power	1000 in.-lbs.
Brake Power	**9000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Triple race/138 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	31 lbs.
Effective Moment (in tower)	**3400 ft.-lbs**

CD-45II – $499.95

For antenna arrays up to 8.5 sq. feet mounted inside tower or 5 sq. ft. with mast adapter.

Low temperature grease good to -30 F degrees. New Test/Calibrate function. Bell rotator design gives total weather protection, dual 58 ball bearing race gives proven support. Die-cast ring gear, stamped steel gear drive, heavy duty, trouble free gear train, North center scale, lighted directional indicator, 8-pin plug/socket on control unit, snap-action control switches, low voltage control, safe operation, takes maximum mast size to 2$^{1}/_{16}$ inches. MSLD light duty lower mast support included.

CD-45D2 – $599.95 with DCU-2

CD-45D3 – $659.95 with DCU-3

Specifications	
Wind Load Capacity (inside tower)	8.5 square feet
Wind Load (w/mast adapter)	**5.0 square feet**
Turning Power	600 in.-lbs.
Brake Power	**800 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/48 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	22 lbs.
Effective Moment (in tower)	**1200 ft.-lbs**

New!

Hy-Gain Programmable DCU-3 Digital Rotator Controller

DCU-3 – $499.95

Hy-gain DCU-3 Digital Controller lets you program 6 beam headings! Gives you full automatic or manual control of your hy-gain HAM or Tailtwister Rotators.

Press a memory button or dial in your beam heading or let *Ham Radio Deluxe* (or other) take control. Your antenna auto rotates precisely and safely to your DX.

DCU-3 automatically jogs your antenna free and safely unlocks it before rotating begins (*great for older rotators with "sticky" brakes*) then turns off your motor before reaching its final heading. Your antenna gently coasts to a stop before the brake re-locks -- greatly reducing damaging overshoots and extending rotator life. Simply press *Left* and *Right* buttons for full manual control and fine tuning.

Bright blue LCD shows current, dialed in and computer controlled beam headings in one degree increments and your call.

Calibrate lets you accurately match your display to your true beam heading. Has USB/RS-232 ports for computer control. Adjustable LCD sleep time. Field upgradeable firmware. 8.5Wx4.3H x9D". 110 VAC. Order DCU-3X for 220 VAC.

DCU-2 Digital Rotator Controller – $459.95
Like DCU-3, but less programmable memories. 110 VAC. Order **DCU-2X**, for 220 VAC.

AR-40 – $399.95

For compact antenna arrays and large FM/TV up to 3.0 square feet wind load area.

Dual 12 ball bearing race. Automatic position sensor never needs resetting. Fully automatic control -- just dial and touch for any desired location. Solid state, low voltage control, safe and silent operation. 2$^{1}/_{16}$ inch maximum mast size. MSLD light duty lower mast support included.

AR-40 Rotator Specifications	
Wind Load Capacity (inside tower)	3.0 square feet
Wind Load (w/mast adapter)	**1.5 square feet**
Turning Power	350 in.-lbs.
Brake Power	**450 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/12 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**5**
Shipping Weight	14 lbs.
Effective Moment (in tower)	**300 ft.-lbs**

Replace your Yaesu Rotator Controller

YRC-1 – $369.95

Hy-gain YRC-1 -- more features, more robust, far less prone to lightning damage. Costs less than repairing!

Easy-to-use -- dial in your beam heading and tap GOTO button. Exclusive 180 degree *AutoReversal*™ for fast longpath operation. All DCU-2 features. Bright blue LCD shows current, dialed-in, computer controlled beam headings, call. USB port for computer control. Extra heavy-duty AC power supply. Fast variable DC motor minimizes overshoot. Intuitive menu. Field upgradeable. For Yaesu G-800/1000/2800/G450/650. AC or DC motors.

YRC-3, $449.95. Like YRC-1 and adds 6 memories.

AR-500 Rotator/Controller – $169.95

UHF/VHF/6-Meter, MFJ-1886 Rotator/Controller and Remote. For use of small VHF/UHF, 6M, TV, FM, the MFJ-1886 wide band receiving loop and other light-weight ham antennas. Rotator is built in a weather-proof one piece cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote, clamps, and all hardware. AR-500 remembers up to 12 directions even after a power outage! Use remote control or direct console. Displays location and relative position.

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An inexpensive wide-band SDR dongle receiver lets you see entire bands on frequency/waterfall computer displays!

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$119.95

If you want to know where the activity is, who's generating splatter, what's in the DX window, how wide your audio is or what frequencies are clear, it's all right there! While receiving on your transceiver, MFJ-1708B-SDR switches your SDR to your antenna showing the entire band. On transmit your SDR is switched out and grounded to protect your SDR. PTT and a failsafe RF sense switches MFJ-1708B-SDR. For HF/VHF/UHF. Monitor multiple bands with multiple SDRs and a multi-coupler.

MFJ-1708B-SDR-S, $129.95. SMA connector for your SDR.
MFJ-1708SDR, $99.95. Original model for HF/VHF.

New B series improvements... The original MFJ-1708 series used one relay and wires to connect the SO-239s. The new B-series uses four relays and connectors on a *single* pc board. This gives you > 50 dB isolation at 300 MHz and > 68 dB at 50 MHz. SWR < 1.16:1 at 50 MHz and < 1.75:1 at 450 MHz at the transmit port. Mute output is a selectable short or open to ground. Use "boat anchors" or modern receivers or key a linear amplifier. Receiver input protection prevents overload from nearby high power signals and from receive to transmit. A hybrid splitter on SDR models reduces loading effect and gives > 15 dB isolation between the SDR REC and XCVR ports to reduce interference. The original MFJ-1708 series is still available.

MFJ Low Noise VLF/HF Receiving Loop

Pull weak signals out of static crashes, atmospheric, man-made and power line noise!

Hear signals 500 KHz to 30 MHz cleaner, quieter than ever before! Power line noise disappears. Rotate its figure 8 pattern and its extremely deep null to completely eliminate an interfering signal or greatly peak a desired one. Fully protected state of-the-art Gali MMICs in push-pull gives you a preamp with extremely high dynamic range, low IMD and 25 dB of low noise gain. Excellent performance on strong and weak signals without overload. 36-inch dia. loop. 1-in. OD 6061 aluminum.

MFJ *wideband* SDR *Discone* Antenna

Receives 25-1300 MHz

MFJ ultra wide-band *Discone* Antenna receives 25-1300 MHz. Perfect for all band SDR reception. Covers 10, 6, 2 Meters, 220 and 440 MHz and 33/23 CM ham bands and everything in between. It is excellent for monitoring multiple bands simultaneously using multiple SDRs and a multi-coupler. Also test any transmitter 50-1300 MHz using a single discone and single coax. Handles 200W. Includes 50 feet coax, stainless steel elements and mounting hardware.

MFJ-1866, $59.95. Like MFJ-1868 but transmits 144-1290 MHz. Coax and mounting hardware not included.

Tuned Indoor SDR Active Antenna

Make your SDR receiver come alive with HF signals, .3-40 MHz, while rejecting interference with MFJ-1020C *tuneable* indoor active antenna! Gain control, telescoping whip.

MFJ-1020C
$119.95

Untuned Indoor SDR Active Antenna

MFJ-1022, $79.95.

Hear weak, noisy VLF to UHF signals. Noise-less feedback gives excellent low noise reception. Handles strong signals.

Active Outdoor Antenna

MFJ-1024
$179.95

World Radio TV Handbook says "MFJ-1024 is a *first rate, easy-to-operate active antenna, quiet, excellent dynamic range, good gain, very low noise factor, broad frequency coverage, excellent choice...*" **Outdoor** mounted 54-inch whip/preamp gives maximum signal and minimum noise. Covers .05-30 MHz. **Indoor** unit: 20 dB attenuator, gain control, 2 receiver and 2 antenna switches.

HF SDR Preselector

MFJ-1040C
$139.95

Tuneable MFJ-1040C lets you copy weak, noisy SDR signals from 1.8 to 54 MHz. Greatly tunes out and reject out-of-band interference. Up to 20 dB gain. Has gain control. Cascode FET/bipolar transistor gives low noise, high gain without overloading. Switches for 2 antennas and 2 receivers. SO-239s. Has 20 dB attenuator. Automatically bypasses when transmitting or use PTT. $6^1/_2$W x $2^1/_2$H x 4D inches.

MFJ LW/MW/SW SDR Preselector/Tuner

MFJ-956
$79.95

Highly rated series-tuned MFJ-956 boosts your desired signals while greatly rejecting interference and preventing serious overload. **Greatly** improves reception 0.15 to 30 MHz. Incredibly effective below 2 MHz. **Super** easy to operate, select band and tune! **Bypass** tuner and ground receiver switch positions. **Compact** 2 x 3 x 4 inches. SO-239 connectors.

MFJ RF Sense Transmit/Receive Switch

MFJ-1708B, $119.95.

Switches your antenna from receiver to transmitter using a relay. Shorts your receiver to ground during transmit. Use RF sensing with adjustable delay or PTT line. Has selectable open/short mute.

Auto switch XCVR between 2 antennas

MFJ-1707B, $119.95.

Switches switches separate transmit and receive antennas on transceivers with only one antenna port. *Example*: Efficient 75M dipole for XMIT and MFJ-1708B low noise MFJ loop for receive -- *no static crashes*!

MFJ

MFJ Enterprises, Inc. 300 Industrial Pk Rd, Starkville, MS 39759
Phone: (662) 323-5869 ■ **Tech Help:** (662) 323-0549 ■ **FAX:** (662) 323-6551 8-4:30 CST, Mon.-Fri.

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MFJ_1708B-SDR_032818_100819DS

MFJ *Telescopic* Fiberglass Masts

Portable, telescoping high-strength fiberglass masts extend way up into the sky! Just pull out sections and lock.

Choose Lightweight-Light-Duty or Super-Strong Thick-Wall models -- 10 to 50 feet long. Each collapses to an easy-to-carry size for true portability.

For quick put-up and take-down, light-duty models have Twist & Lock sections and heavy-duty thick wall models use military style *QuickClamps*™ or stainless steel hose clamps.

Use them for traveling, camping, at hotels, hamfests, field day, DX-peditions. Put up full size full performance inverted Vee, dipole or vertical antenna in minutes at heights that will snag you real DX.

Use multiple telescoping masts to make loops, quads, rotatable dipoles even beams.

← *Light Duty Lightweight Fiberglass Masts*

So lightweight you can take them anywhere!

MFJ's most popular MFJ-1910 is 33 feet long, 3.3 lbs.

MFJ-1910, $99.95. 33 ft., light duty w/top tie ring.
MFJ-1911, $109.95. 20 ft., light duty w/top tie ring.
MFJ-1913, $109.95. 28 ft., lightweight w/top tie ring.
MFJ-1915, $159.95. 25 ft., for heavier duty use.
MFJ-1916, $179.95. 34 ft., for heavier duty use.
MFJ-1917, $189.95. 43 ft., heavier duty w/top tie ring.

Super-strong .125" Thick-Wall Fiberglass Masts

Use for temporary or permanent wire antennas, small beams or verticals. **Best seller** is 50 ft. long, just 26 lbs.

Heavy Duty Models: All have QuickClamps™ →

MFJ-1908HD, $289.95 is 48 ext., 7.75-ft. collapsed, has 2 1/2" OD bottom, 1" OD top, seven 7.75-ft. sections, 24 lbs.
MFJ-1906HD, $249.95 is 38' extended, 6 feet collapsed, has 2 1/2" OD bottom, 1" OD top, seven 6-foot sections, 24 lbs.
MFJ-1904HD, $179.95 is 25' extended, 4 feet collapsed, has 2 1/2" OD bottom, 1" OD top, seven 4-foot sections, 14 lbs.
MFJ-1904H, $159.95. 22' ext., 5' collapsed, 9 lbs. 2 1/2" OD.
MFJ-1902H, $139.95, 10' ext., 38" collapsed, 5 lbs. 2 1/2" OD

Standard Models: H models have QuickClamps™

MFJ-1906, $159.95/MFJ-1906H, $219.95, 33 feet, ext., 6 ft. collapsed, six 6-ft. sections, 13 lbs. 2" bottom, 3/4" top OD.
MFJ-1908, $199.95/MFJ-1908H, $259.95, 41' ext., 7.75 ft. collapsed, six 7.75-ft. sect., 16 lbs. 2" bottom, 3/4" top OD.

Mast Accessories

MFJ-1900, $79.95. Mount clamps mast to mounting pipe.
MFJ-13S, $69.95. 5 Military *QuickClamps*™. Fit 3/4" to 2" OD.
MFJ-13HD, $69.95. Extra set clamps, 1- 2 1/2" masts.

Mast Guy Ring Sets

Fits masts 3/4" to 1 1/4" dia OD. **MFJ-2830X, $9.95**, *fiberglass*; **MFJ-2840X, $12.95**, *aluminum.*

Left: *Stainless Steel Hose Clamps recommended for permanent installations. Fiberglass is slotted.*

Right: UV protected Military grade *QuickClamps*.Guy 2 levels when fully extended.

18' Telescopic Mast & Tripod

MFJ-1919EX, $179.95.
Put your antennas up high anywhere with this super-strong 18 foot telescoping fiberglass mast and MFJ-1919 heavy duty steel tripod. QuickClamps™ lower mast to 5 feet. Mast has thick 1/8 in. wall, .75" top, 1.5" bottom dia. 15 lbs. Steel tripod has braced triangle base, non-skid feet, mast lock.

MFJ-1918EX, $109.95.
MFJ-1918 tripod has super strong 9.5 foot telescoping fiberglass mast. 3.8 feet collapsed. *QuickClamps*™. Thick 1/8 inch wall, .75" top, 1" bottom diameters. 6.5 lbs.

Tripods Only

MFJ-1921, $199.95, Giant tripod base spreads to 8 feet! Supports massive antennas. Adjustable length non-skid legs accommodates uneven ground surfaces. Optional foot anchors **MFJ-1905, $34.95**, see **Tripod Anchors** bottom right. 5.75Hx7D feet collapsed. 14 lbs.

MFJ-1919, $109.95, *Large tripod* base spreads to 4.8 feet. Supports 100 pounds. 7.8 feet, 1.4 inch diameter mast. 4.5H x .5D feet collapsed. 9.75 lbs.

MFJ-1918, $69.95, Smaller tripod base spreads to 2.75 ft. Support 66 lbs. 6 foot, 1" dia. mast. 3.2H x .3D ft. collapsed. 6.75 lbs.

80-6 Meter Antenna

MFJ-2980 $115.95 40-6 Meters

MFJ-2982 $169.95 80-6 Meters

3.8 foot fiberglass mast telescopes to a 31 foot self-supporting high performance 80-6 Meter vertical antenna in minutes!

Quarter wave performance on 40 Meters, halfwave on 20M. High-Q air wound loading coil. Use antenna tuner for 30, 20, 15, 12, 10, 6 Meters. 600 Watts SSB/CW.

Use as temporary, portable or permanent antenna for home, RVs, camping, field day, hamfest, DX-pedition.

Includes four 12 foot radials. Current balun reduces feedline radiation and pattern distortion.

MFJ *"HamStick"* Isolated Dipole

MFJ-347 $24.95

Build your own 80-6 Meter *mini*-dipole using two HF mobile whips! Only MFJ-347 mount *isolates* dipole elements and lets you use a balun to give a true *balanced dipole*. Prevents pattern distortion, noise pickup and RFI radiation from RF on coax shield. Solid aluminum. Use mast up to 1 1/4" OD.

3/8-24 Hamstick

MFJ-342T $15.95 Mount 3/8-24 HF/VHF hamsticks vertically or horizontally on masts up to 1 inch. Built-in SO239 connector.

MFJ Balcony Mount

MFJ-1907 $49.95

Mount *multiple* HF/VHF hamsticks, verticals, dipoles vertically and/or horizontally on your apartment/condo balcony. High-strength aircraft aluminum extends out 14". Two U-bolts mount up to 1 1/2" diameter.

Tripod Anchors

MFJ-1905 $34.95

Securely anchor tripod to ground with these 3 stainless steel foot braces and your stakes. For high winds, unlevel ground, tall antennas. Fits legs to 1 1/2"OD.

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MFJ...the World Leader in Ham Radio Accessories!

MFJ G5RV Antennas

Operate all bands 10 through 160 Meters with a single wire antenna!

***The famous** G5RV antenna is the most popular ham radio antenna in the world!*

It's an efficient, *all* band 102 foot long antenna – shorter than an 80 Meter dipole. Has 32.5 foot ladder line matching section ending in SO-239 connector for your coax feedline.

MFJ-1778
$69.95

Use horizontally or as Inverted Vee or Sloper with just one support. 1500 Watts.

Operate all bands 80-10 Meters with an antenna tuner and even 160M with ground.

Fully assembled with *ceramic* end and fiberglass center insulators. *Hang and Play™* – add coax, rope to hang and you're on air!

MFJ-1778M, $59.95. *Half-size,* 52 foot *G5RV JUNIOR for limited space.* 40-10 Meters with tuner. Full 1500 Watts.

MFJ All Band Classic Doublet

MFJ 102 foot *all band* doublet covers 160-6 Meters with balanced line tuner. Super strong custom fiberglass center insulator relieves stress on 100 foot ladder line.

MFJ-1777
$79.95

Glazed ceramic end insulators. 1500 Watts.

RF Isolator

MFJ-915 *RF Isolator* prevents unwanted RF from traveling on the outside of your coax shield into your transceiver. This unwanted RF can cause painful RF "bites" when you touch your microphone or volume control, cause your display or settings to go crazy, lock up your transceiver or turn off your power supply. In mobile installations, stray RF could cause your car to do funny things even blow your car computer. Clear up these problems, plug an MFJ-915 between your antenna and transceiver. 1.8-30 MHz, 1500 Watts. 5 x 2 inches.

MFJ-915
$39.95

MFJ-919, $69.95. 4:1 current balun,1.5 kW.
MFJ-913, $39.95. 4:1 balun, 300 Watts.

True 1:1 Current

Balun & Center Insulator

True 1:1 *Current Balun/Center Insulator* forces equal radiator currents in dipoles for true dipole radiation pattern. Reduces coax radiation and field pattern distortion – your signal goes where *you* want it. Reduces TVI, RFI and RF hot spots. *Don't build a dipole without one!* 50 hi-permeability ferrite beads on high quality RG-303 *Teflon®* coax and *Teflon®* SO-239. 1.5kW 1.8-30 MHz. Stainless steel hardware. 14 gauge stranded copper wire is *directly* connected to your antenna. 5 x 2 inches. Heavy duty weather housing.

MFJ-918
$39.95

2-Position Antenna Switch

MFJ-1702C, $49.95. 2-position antenna switch, lightning surge protection, center ground. SO-239s.

Lightning surge protectors

MFJ-270, $24.95. 400W. **MFJ-272, $34.95.** 1500 W. Gas discharge tube shunts 5000 amps peak.< 0.1 dB loss. 1 GHz. SO-239s.

MFJ-16C06, $9.45. 6-pack *glazed ceramic* end/center ant. insulators.

MFJ-16B01, $24.95. Molded high strength center insulator. SO-239.

MFJ-16D01, $9.95. 450 Ohm fiberglass end/center insulator with ladder line stress relief and SO-239 mount.

MFJ-18H100, $44.95. 100 feet, 450 Ohm ladder line, 18 gauge copper clad.

80-10 Meter End-Fed Half Wave antenna

Cover all bands with one single wire and no tuner!

MFJ-1982HP
$109.95

No tuner needed!
All band 80-10M EFHW antenna

Get-on-the air on all bands 80-10 Meters with just one wire and one support (pole or tree) and no tuner or long counterpoise.

Installs anywhere in minutes! Rugged *insulated*-wire radiator prevents detuning when contacting limbs/branches. "*No-snag*" end insulator slides over branches, leaves.

Toss over a high limb for inverted-V or sloper or go vertical with an inverted-L.

Dark jacketed wire is virtually invisible – *don't let antenna restrictions keep you off the air!* Great for emergencies.

EFHWs naturally resonate on the 1/2-wave fundamental frequency and odd/even harmonics. Covers 80/40/30/20/17/15/12/10 Meters without traps, stubs or resonators.

Broad-band matching transformer at feed point gives SWR so low you may never need a tuner. Compensating inductor optimizes SWR. 800 Watts SSB/CW. 132 feet jacketed antenna wire.

MFJ-1984HP, $89.95. Like MFJ-1982HP but 40-10M. 66 feet jacketed wire.

See *www.mfjenterprises.com* for 30 Watt QRP and 300 Watt models.

Dual Band Dipoles

MFJ-17758, $99.95. Operate 80/40 Meters with a short 85 foot dipole. Full-size on 40 Meters with ultra-efficient end-loading on 80 Meters. 1500 Watts. Super-strong custom molded center insulator with SO-239 connector and hang hole. Ceramic end insulators. 7-strand, 14 gauge hard copper wire. No tuner needed!

MFJ-17758
$109.95
80/40 Meters

MFJ-17754, $69.95. Like MFJ-17758 but is only 42 feet. Operate 40/20 Meters. Full-size on 20 Meters, ultra-efficient endloading on 40 Meters. 1500 Watts.

Single Band Dipoles

Ultra high quality center fed dipoles give years of troublefree service. Custom injection-molded UV resistant center insulator has built-in SO-239 and hanging hole. Glazed ceramic end insulators. 7-strand, 14-gauge hard copper antenna wire. 1500 Watts. Use horizontally or as sloper or inverted vee. Simply cut to length with provided cutting chart.

MFJ-1779A
$79.95
160M, 265 ft.

MFJ-1779B
$59.95
80-40M, 135 ft

MFJ-1779C
$39.95
20-6M, 35 ft.

OCFD Dipoles

No tuner needed!

MFJ *Off-Center Fed Dipoles* use MFJ's exclusive *ExactRatio™* RF broadband transformer to give low SWR and maximum bandwidth on 40/20/10/6 Meters. A Guanella current balun kills feedline radiation, pattern distortion, SWR shifts, RFI and noise pickup. Install anywhere and get the same predictable performance regardless of feedline length. You get ground reinforced gain over verticals. Use horizontally, inverted vee, sloper. 98% efficient, 14 gauge, 7-strand copper wire, ceramic end insulators.

MFJ-2012
$89.95
1500 Watts

MFJ-2010
$69.95
300 Watts

MFJ Enterprises, Inc. 300 Industrial Pk Rd, Starkville, MS 39759
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iC for iCOM!
Our iC element has been specially designed to work with iCOM transceivers. All Heil headsets are available in an iC version.
HEIL
HeilHamRadio.com

Free Catalog/Dealers/Manuals Online – Visit: www.mfjenterprises.com or call toll-free 800-647-1800

MFJ...the World Leader in Ham Radio Accessories!

MFJ Weather-Proof Window Feedthrough Panels

Weather-proof window feedthrough panels bring coax, balanced lines, HF/VHF/UHF antennas, random wire antennas, ground, rotator/antenna switch cables and DC/AC power into your hamshack without drilling through walls!

MFJ Weather-Proof Window Feedthrough Panels mount in your window sill. Lets you bring all your antenna connections into your hamshack without drilling holes through walls.

Simply place in window sill and close window. One cut customizes it for any window up to 48 inches. Use horizontally or vertically. Connectors are mounted on inside/outside stainless steel plates and attached to a 4 foot long, $3^1/_2$ inch high, $^3/_4$ inch thick pressure-treated wood panel.

Real Western Red Cedar wood is naturally resistant to rot, decay and insects -- lasts longer, maintenance-free. Pitch and resin free for a wide range of beautiful finishes or leave it in its naturally beautiful raw finish. Edges sealed by weather-stripping. Seals and insulates against all weather conditions. Includes window locking rod.

Inside/outside stainless steel plates ground all coax shields. Stainless steel ground post brings ground in.

MFJ-4603 Universal Window Feedthrough Panel

MFJ-4603
$109.95

Four 50 Ohm Teflon® SO-239 coax connectors lets you feed HF/VHF/UHF antennas at full legal power limit.

A 50 Ohm Teflon® coax N-connector lets you use any antenna up to 11 GHz, including 450 MHz, UHF, satellite, moon bounce and 2.4/5.8 GHz Wi-Fi antennas.

A 75 Ohm, 1 GHz F-connector makes it easy to bring in television, Satellite, HD, cable TV and FM radio signals.

A pair of high-voltage ceramic feedthru insulators lets you bring in 450/300 Ohm balanced lines directly to your antenna tuner.

Has random/longwire antenna ceramic feedthru insulator.

5-way binding posts lets you supply 50 Volts/15 Amps DC/AC power to your outside antenna tuners/relays/switches.

Stainless ground post brings in ground connection, bonds inside/outside stainless steel panels together and drains away static charges.

MFJ's exclusive Adaptive Cable Feedthru™ lets you bring in rotator/antenna switch cable, etc. without removing connectors (up to $1^1/_4$ X $1^5/_8$ in). Adapts to virtually any cable size. Seals out rain, snow, adverse weather.

3 Coax, Balanced Line, Random Wire

Best Seller! 3 Teflon® coax connectors for HF/VHF UHF antennas. Separate high voltage ceramic feed-thru insulators for balanced lines and longwire/random wire, Stainless steel ground post.

MFJ-4602
$79.95

6 Coax

6 high quality Teflon® coax connectors for HF/VHF/UHF antennas. Stainless steel ground post. Full 1500 Watt legal limit.

MFJ-4601
$69.95

4 Balanced Line, 2 Coax

4 pairs of high-voltage ceramic feed-thru insulators for balanced lines and 2 coax connectors.

MFJ-4600
$89.95

5 Cables, any-size

5 Adaptive Cable Feedthrus™. Pass any cable with connector: 2 cables with large connectors up to $1^1/_4$ x $1^5/_8$ inches and 3 cables with UHF/N size coax connectors. Seals out weather.

MFJ-4604
$114.95

All-Purpose FeedThru/CableThru™

Stacks MFJ-4603 and MFJ-4604! Gives you every possible cable connection you'll ever need through your window without drilling holes in wall – including UHF, N and F coax connectors, balanced lines, random wire, ground, DC/AC power and cables of any size for rotators, antenna switches, etc.

MFJ-4605
$179.95

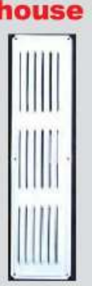
Bring cables through the eave of your house


MFJ-4616
shown with standard full size vent (not included) it replaces. For 6 Cables

$34.95

MFJ-4613
shown with standard half size vent (not included) it replaces. For 3 Cables

$19.95

Replace your standard air vents on the eave/sofitt of your house with these MFJ AdaptiveCable™ Air Vent Plates and...

Bring in coax, rotator, antenna switch, power cables, etc. with connectors up to $1^1/_4$ x $1^5/_8$ inches!

Sliding plates and rubber grommets adjust for virtually any cable size to seal out adverse weather, insects and varmints. Use existing vent hole, mounting screws and screw holes.

AdaptiveCable™ Wall Plates

MFJ-4614
For 4 Cables
$44.95

Bring nearly any cable -- rotator, antenna switch, coax, DC/ AC power, etc. -- through walls without removing connectors (up to $1^1/_4$x$1^5/_8$ inches). Sliding plates and rubber grommets adjust hole size to weather-seal virtually any size cable.

Includes stainless steel plates for each side of wall, sliding plates, rubber grommets, weather stripping and screws.

MFJ-4612
For 2 Cables
$34.95

MFJ-4611
For 1 Cable
$19.95

Free Dealer/Catalog/ Manuals/Instructions – Visit: www.mfjenterprises.com or call toll-free 800-647-1800

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MFJ...the World Leader in Ham Radio Accessories!

MFJ IntelliTuner™ Automatic Tuners

More hams use MFJ tuners than all other tuners in the world!

World's most advanced Automatic Antenna Tuners feature world renowned MFJ AdaptiveSearch™ and AutomaticRecall™ algorithms -- world's fastest ultra-wide range tuning. Nine World Class models! Choose your features: Digital/Analog/Audio SWR-Wattmeter, Antenna Switch, Balun, Radio Interface, Digital Frequency Readout, Remoteable, Coax/Balanced Lines/Wire Tuning, Field Upgradeable...

MFJ-998 1500 Watt Legal Limit IntelliTuner™

Only the MFJ-998 gives you fully automatic antenna tuning for your legal limit full 1500 Watts SSB/CW linear amplifier!

Ultra-fast Automatic Tuning
Instantly match impedances from 12-1600 Ohms using MFJ's exclusive IntelliTune™, Adaptive Search™ and InstantRecall™ algorithms with over 20,000 VirtualAntenna™ Memories.

Safe auto tuning protects amp
MFJ's exclusive Amplifier Bypass Control™ makes tuning safe and "stupid-proof"!

MFJ-998 $739.95

Digital/Analog Meters
A backlit LCD meter displays SWR, forward/reflected power, frequency, antenna selected, an auto-ranging bargraph power indication, and much more.

Has quick-glance auto-ranging Cross-Needle SWR/Wattmeter.

MFJ VirtualAntenna™ Memory
MFJ new VirtualAntenna™ Memory system gives you 4 antenna memory banks for each of 2 switchable antenna coax connectors. Select up to 4 antennas on each antenna connector. Each antenna has 2500 memories, 20,000 total. Has binding post for end-fed long wire antennas.

Download & Upgrade Remotely
Download from internet and upgrade your MFJ-998 firmware as new features are introduced.

Plus Much More!
Built-in radio interface controls most transceivers.

Automatically bypasses with excessive tuning power.

Use balanced line antennas with external **MFJ-912, $69.95**, 1.5 kW 4:1 balun.

Small 13W x 4H x 15D inches easily fits into your ham station. 8 pounds. Requires 12-15VDC at 1.4 amps maximum or 110 VAC with **MFJ-1316, $29.95**.

For 600 Watt amps
AL-811/ALS-600/ALS-500

MFJ-994B $379.95

For 600 Watt amps like Ameritron AL-811/ALS-600/ALS-500M. Matches 12-800 Ohms. 10,000 Virtual Antenna™ memories. Cross-Needle SWR/Wattmeter. 10W x 23/4H x 9D inches.

No Matter What™ Warranty
Every MFJ tuner is protected by MFJ's famous one year **No Matter What™** limited warranty. We will repair or replace your MFJ tuner (at our option) for a full year.

300 Watt Best Seller
Digital Meter, Ant Switch, Balun

MFJ-993B $299.95

The world's best selling automatic antenna tuner is highly acclaimed the world over for its ultra high-speed, wide matching range, reliability, ease-of-use! Matches virtually any antenna.

300 Watt Extra Wide Range
SWR/Wattmeter, 10000 VA Memories

MFJ-991B $259.95

Extra-wide matching range at less cost. Exclusive dual power level: 300 Watts/6-1600 Ohms; 150W/6-3200 Ohms. Cross-Needle SWR/Wattmeter.

200 Watt Compact
Digital Meter, Ant Switch, Wide Range

MFJ-929 $269.95

World's fastest compact auto tuner uses MFJ Adaptive Search™ and InstantRecall™ algorithms. 132,072 tuning solutions instantly match virtually any antenna with near perfect SWR.

200 Watt *MightyMite™* *Matches IC-706, FT-857D, TS-50S*

MFJ-939KIY
$169.95

No *extra space needed!* Just set your IC-706/7000, FT-857D, TS-50S on top of this matching low-profile automatic tuner -- it's all you need for a completely automated station using *any* antenna! Just tune and talk!

G5RV Antenna

MFJ-1778 $69.95

Covers all bands, 160-10 Meters with antenna tuner. 102 ft. long. Can use as inverted vee or sloper. Use on 160 Meters as Marconi.1500 Watts. Super-strong fiberglass center/feedpoint insulators. Glazed ceramic end insulators. All hand-soldered connections. Add coax, some rope and you're on the air! **MFJ-1778M, $59.95.** G5RV Junior. Halfsize, 52 ft. 40-10M with tuner, 1500 Watts.

200W Weather-sealed
For Remote/Outdoor/Marine

Fully weather-sealed for remote Outdoor/ Marine use! Tough, durable, built to last the elements for years.

MFJ-926B $329.95

300W BRT Tuner

MFJ-993BRT
$339.95

300 Watt remote automatic antenna tuner matches widerange 6-1600 Ohms impedances 1.8 to 30 MHz Handles 300W SSB/CW. Tough, durable, weather-sealed, includes power injector.

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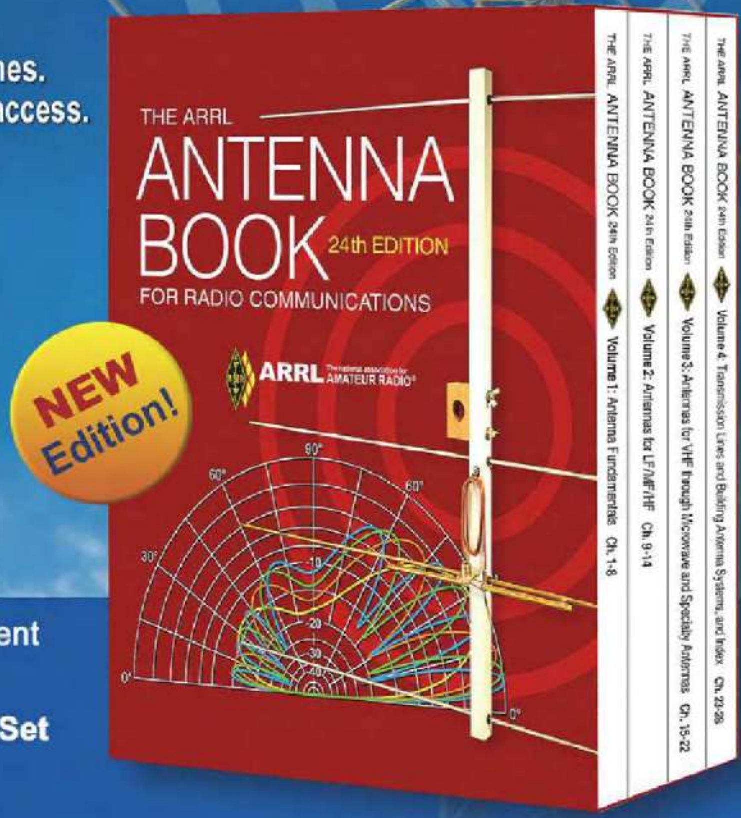

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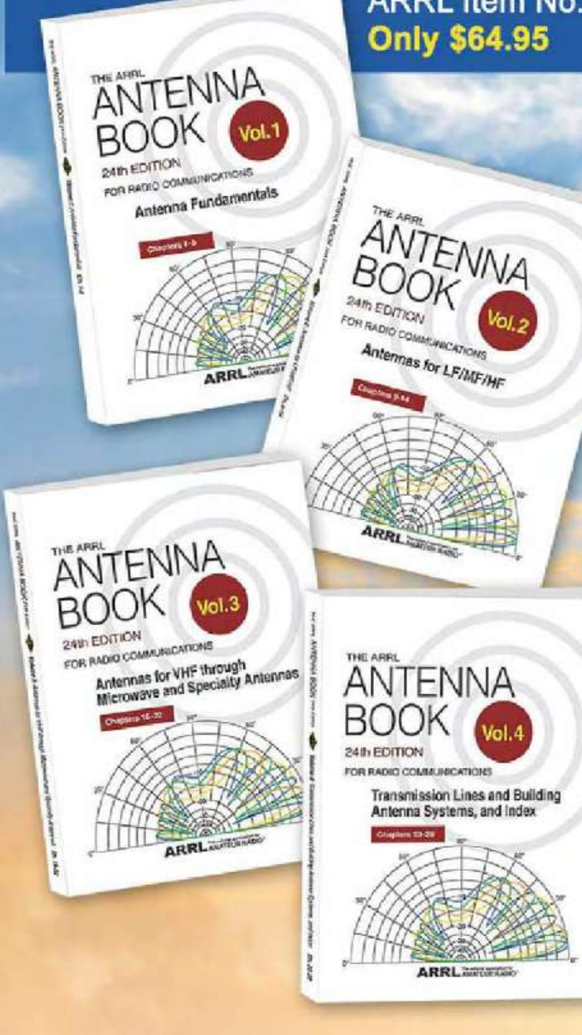

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New, improved MFJ-989D legal limit antenna tuner gives you better efficiency, lower losses and a new true peak reading meter. It easily handles full 1500 Watts SSB/CW, 1.8 to 30 MHz, including MARS/WARC bands.

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Makes contesting easy -- Calls CQ, sends your call, does contest exchanges -- in your own natural voice

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